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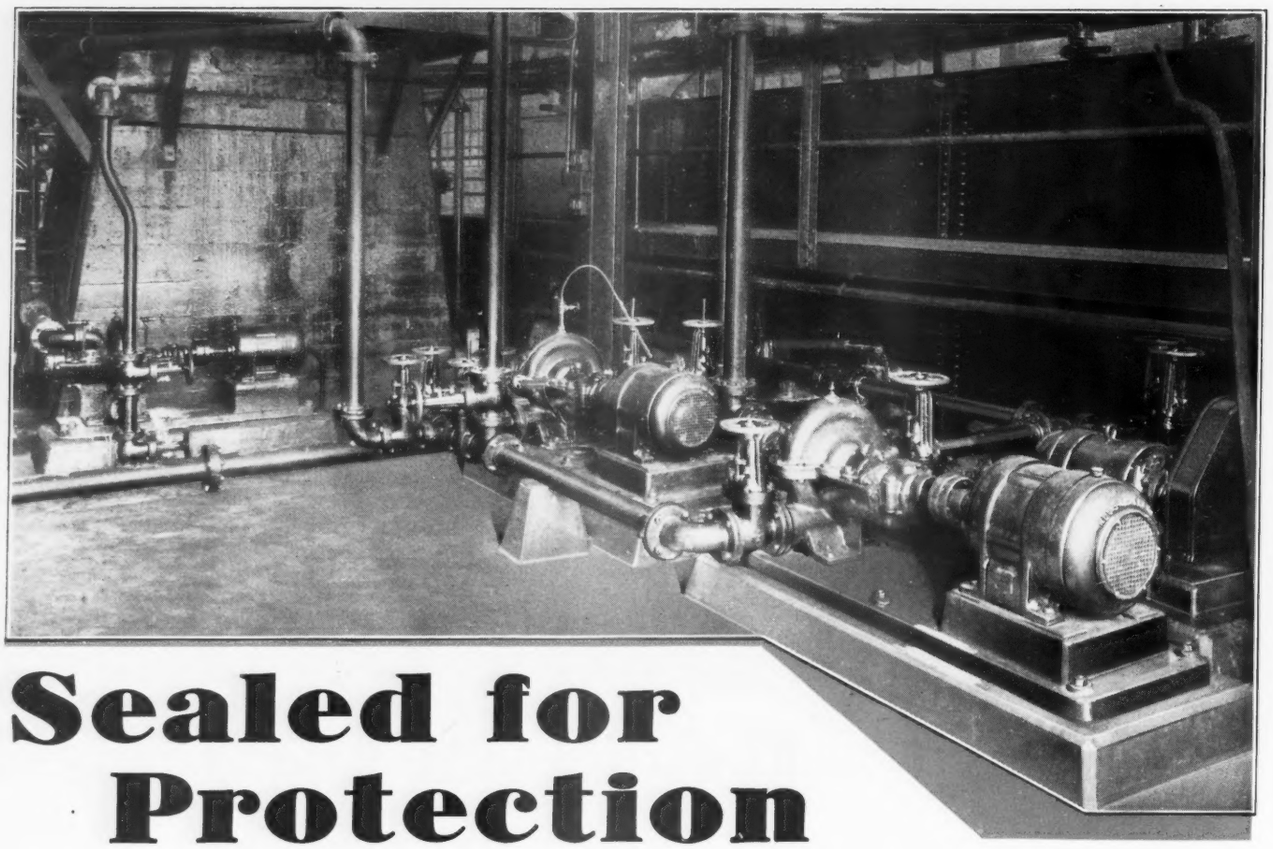
INDUSTRIAL ENGINEERING

MAINTENANCE ENGINEERING
IN PLANTS, MILLS, AND FACTORIES

A McGraw-Hill Publication

SEPTEMBER - 1930

For Cover Story see page 470



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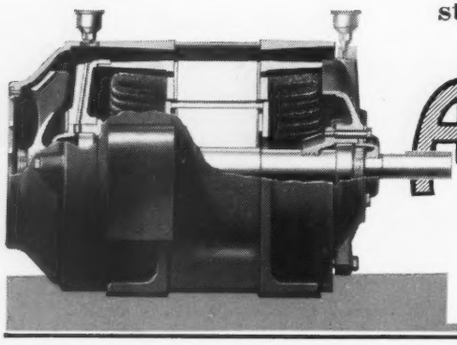

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INDUSTRIAL ENGINEERING

Founded in 1882 as Electrical Review. Consolidated with it—Western Electrician and Industry Illustrated.

Maintenance Engineering in Plants, Mills, and Factories, as Applied to Electrical and Mechanical Equipment and Buildings

L. C. MORROW, *Editor*

Volume 88, Number 9

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Noticeable during the past two years has been the increasing use in industry of electric heat and the multiple V-belt drive. They are in no way related in application; are referred to together here because there are articles on both in this issue.

In the concluding part of his article on 64 applications of electric heat, beginning page 449, Wirt Scott gives additional usable facts and figures.

Stephens in the opening article of the issue, analyzes the V-belt from an engineering point of view. You will "know" the drive when you get through reading his treatise.

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INDUSTRIAL ENGINEERING

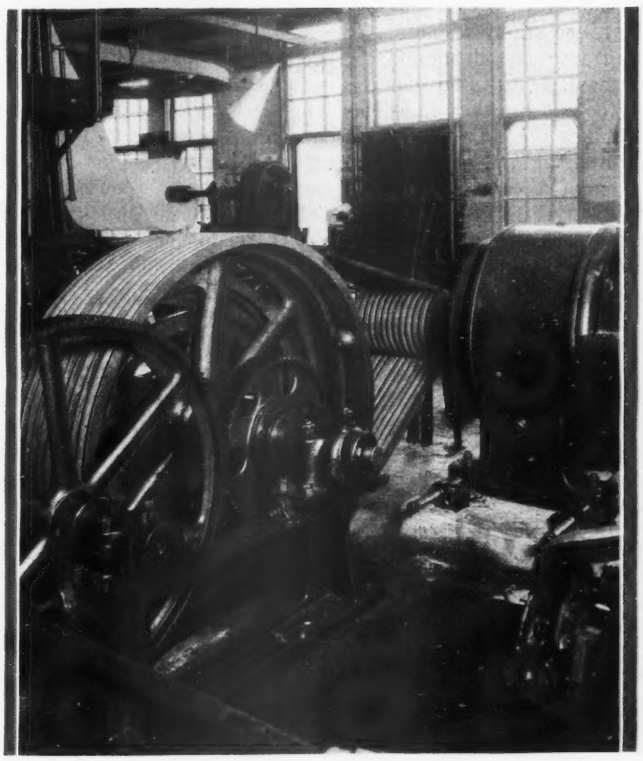
Maintenance Engineering in Plants, Mills, and Factories, as Applied to Electrical and Mechanical Equipment and Buildings

A McGraw-Hill Publication, founded 1882

Volume 88 **CHICAGO, SEPTEMBER, 1930** *Number 9*

By WALTER H. STEPHENS

H. W. Sharp Company
Portland, Oregon



Courtesy Allis-Chalmers Manufacturing Company

Driving a calender stack in a paper mill; the sheave rim is pressed on the old clutch center gear.

V-BELT DRIVES—

their application and selection

THE introduction of electric motors and dynamos into every kind of mill and factory has been going on for so many years, since they passed their experimental stage, that today it is almost universal practice to equip a plant, whether new or old, with electric-power units.

However, due to the high rotating speed of motors and dynamos, it ever has been a problem to apply or transmit their power conveniently. A gratifying solution of the problem has come with the development during the past few years of the V-belt drive. The more this type of drive has been observed by engineers and plant operators in large power drives the more enthusiasm it has evoked.

But, ideal as it is for primary power transmission, it has its own field, is limited to that field, and must not be regarded as a general substitute for flat belts. It does not even compete with flat belts because its application is ideal only under certain conditions where the flat belt should not be used.

Means must be provided for only a slight take-up on V-belts, just enough to compensate for wear or stretch, which amounts to very little. Take-up to secure added tension is not necessary; in fact, the drive cannot be operated with tighteners. Obviously, it is not readily adaptable for long-center drives or from lineshaft to lineshaft. Aside from applications on individual machines its best application is for primary drives from power units.

The name V-belt must have been taken from the fact that the grooves in which the belts run are V-shaped.

The belt itself is not V-shaped, but is trapezoidal in section. It is made up endless in much the same fashion as are automobile tires, with fabric cords imbedded in rubber. The Dayton Rubber Company makes its "Cog-Belt" in large pieces and cuts the individual belts from the piece. Allis-Chalmers, Gilmer, and others mold their belts.

Each of the several manufacturers of V-belts makes belts of five standard sizes of section. Each section is made in a number of lengths, most of which are standard among the same manufacturers, although one specifies the inside length, another the outside length, and another the pitch length. Although there is some difference in the internal structures of the various makes of V-belts, there seems to be no essential difference in the working service they render when properly designed and installed. In Fig. 1 are shown the five standard sizes.

There seems to be some difference of opinion on the part of manufacturers about the shape of grooves in which the belts should run. The included angle made by the sides of the belts is 38 deg., which seems to be standard. The angle included by the two sides of the sheave grooves, according to one manufacturer, is from 34 to 36 deg. for his driving sheaves, depending upon their diameter, and 38 deg. on the driven sheaves. If there is any difference in the behavior of the belts in actual work due to the difference in the angles of the grooves, I have been unable to detect it by casual observation. It appears likely that any difference that might exist would be too small to justify the careful testing necessary for its determination.

It seems to me to be much more to the point to give serious attention to the production of the sheaves. There have been failures of V-belt drives due to the roughness of grooves causing rapid wear and replacement of belts. The grooves must be accurately machined and very smooth. Fig. 2 shows the sheave grooves for the various belts that the writer has seen in many installations. Thousands of sheaves made to these dimensions have been operating for years with perfect satisfaction and with V-belts of various manufacturers. The belts must ride on the sides of the grooves rather than on the bottom; otherwise the squeezing or wedging action of the belt in the groove will be lost.

The necessity of having the grooves accurately machined may be seen by referring to Fig. 3. The grooves are shown exaggerated, one larger than the other, the belts having the same section set down in the grooves unequally. This causes a difference in the diameters of the pitch circles. Anyone may see readily what will happen. There will be slippage between the belts and the grooves to equalize the discrepancy in pitch diameters. This will result in fast wear on the belts as well as the grooves, heating up of the sheaves, and consequent loss of power. To do accurate work the grooves should be turned to gage, a practice not followed usually by the average machine shop that just turns an occasional sheave because as much time would be required to make an accurate gage as to turn the sheave.

A properly designed V-belt drive will show an efficiency of about 99 per cent. The V-belt drive is extremely flexible and shock-absorbing, and without slip. A pull on the belt will tend to turn the sheave. If the sheave wheel resists the turning, the belt is squeezed deeper into the groove, increasing the coefficient of friction.

The V-belt drive is noiseless. It has very large overload capacity and sheaves can be made to give ratios as desired up to 7:1. Moreover, this drive puts a minimum of pressure on the bearings because it needs no initial outside tension, and allows the elimination of outboard bearings in some cases.

The life of V-belts cannot be accurately stated, because they have been in use but comparatively few years. However, it seems safe to expect as long life from these belts as from flat belts operating under the same conditions. One installation under the writer's observation has been running for over three years in very severe service conditions of dust and dirt

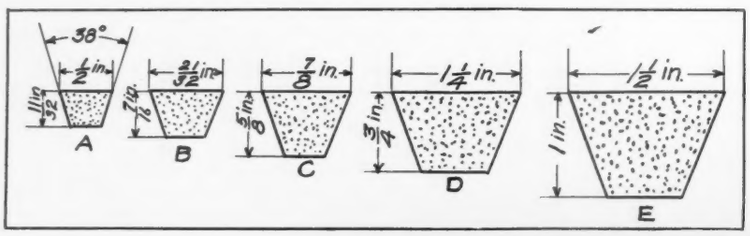
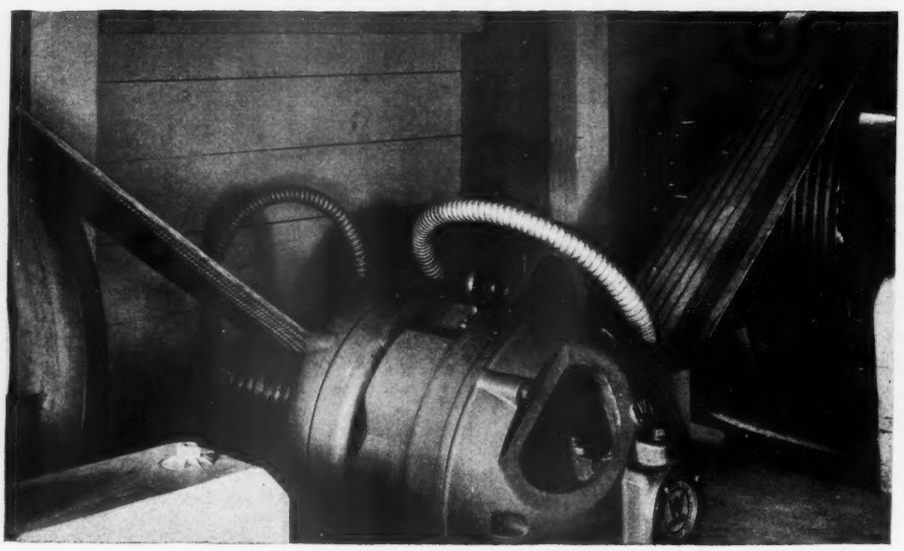
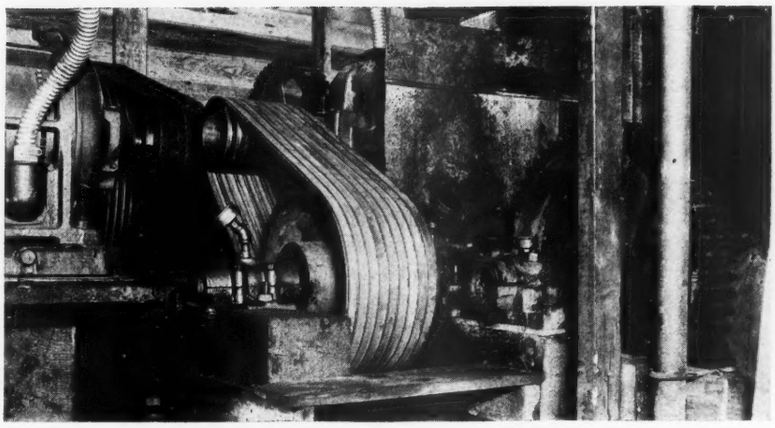


Fig. 1—Section dimensions of the five standard sizes of V-belts.



A fine example of flexibility is shown on the right: Driving a flat screen in a paper mill. Centers are very close. Ratio is 7 to 1. The driven shaft is ¼ in. in 12 in. out of level (meaning that belts are slightly twisted).

Courtesy Dayton Rubber Manufacturing Company



Courtesy Dodge Manufacturing Company

An example of severe service—driving crushers.

and exposure to weather in a rock crushing and screening plant. The grit has caused the grooves in the sheaves to wear noticeably, but the belts are running along in fine shape.

There have been some failures of V-belt drives. In every case that I have observed the direct cause has been poor design. Too much stress cannot be put on the fact that all factors entering into the design of a drive must be carefully considered and none should be slighted. The same judgment that the engineer uses to design a structure by applying the proper factors of safety must be used in designing V-belt drives. Unfortunately—I state this as a warning—that is not always done. Recently such drives on dry kiln fans came to my attention. They had been designed by engineers who should know how. Nevertheless the sheaves had to be replaced with new ones to permit two more belts on each drive. Evidently the proper factors had not been applied.

Perhaps one reason why the drive has not been more universally adopted has been the relatively high first cost, due partly to the fact that each sheave has had to be turned individually.

Now, one manufacturer has on the market a line of pressed steel sheaves with interchangeable bushings so that sheaves may be ordered out of branch office stock. These sheaves are made up of sections assembled on an iron core. The grooves are smooth and dead right as to dimensions.

One virtue of the drive is that if one of the belts gives out the drive may run along without it as the other sheaves will carry the load. One manufacturer has taken advantage of this fact in a novel way. He has a long system of chain conveyors carrying "hog fuel" to his boiler room. This is one of the meanest materials in the world to handle and is apt to jam up the works at any time without notice. The conveyors were driven by a V-belt drive with four "C"-section belts. Two of the belts have been removed, the load being carried by the remaining two belts. The result is that when there is a jam two relatively cheap V-belts are ruined rather than a heavy chain or some other expensive part. It makes an excellent "weak link" in a chain and the idea is worth using in other work.

It is recommended that ratios be kept down to 6:1, or below if possible. On the other hand there is in a lath mill a drive with a ratio of 8:1 that has been giving excellent results for a long time. A lot depends upon the design. The sheaves should be balanced statically, and where speeds are high they should be balanced dynamically. The small sheave will generally generate a noticeable amount of heat due to the friction of the belt in the groove and should be shaped and turned so as to allow for the greatest dissipation of heat. Sometimes there is enough heat to deteriorate the belts if this point is overlooked. V-belts, like ordinary rubber belts, are not suitable where oil and excessive heat prevail.

The speed at which a V-belt should operate may be 1,000 to 5,000 ft. per min. It does not pay to use speeds much lower than 1,000 or as high as 5,000. Between 3,000 and 4,000 are the best speeds. Usually sheave diameters may be chosen to secure the right speed, or by using a smaller belt section and more of them, or vice versa, lower or higher belt speeds may be obtained. For harder drives, such as compressors, conveyors, hoists, etc., a large number of belts with small section is preferable to fewer belts of large section.

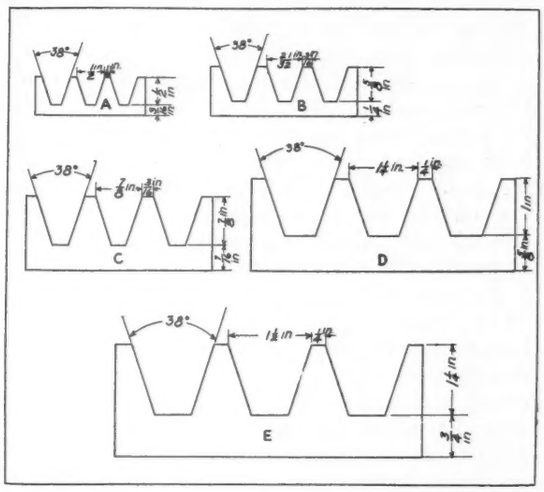


Fig. 2—Rim sections of V-belt sheaves.

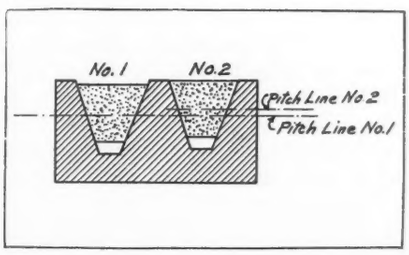


Fig. 3—Grooves of different sizes cause differences in the diameters of the pitch circles.

Designing a Drive

Having a power unit for which it is desired to design a drive, say a motor of given horsepower and speed, it is usual to assume a diameter of driving sheave suitable for the size of motor to give a desirable speed of belt. The recommended diameters for various belt sections, together with the minimum allowable diameters are as follows:

					Minimum		
"A"	Section	6	in.	O.D.—	2½	in.	O.D.
"B"	"	7	"	"	4	"	"
"C"	"	9	"	"	6	"	"
"D"	"	10	"	"	8	"	"
"E"	"	12	"	"	10	"	"

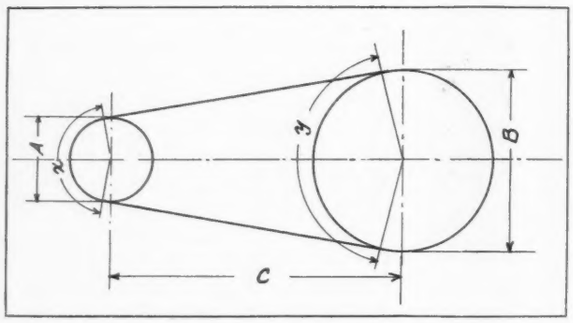


Fig. 4—Arc-of-contact diagram.

With the size of driving sheave determined we next refer to the speeds in feet per minute, Table I. Taking the belt speed therefrom we determine the corresponding horsepower per belt, shown in Table II. Dividing the horsepower of the motor by that figure gives the number of belts required. The horsepower of the motor should always be used in the computations rather than the calculated load which may sometimes be less than the motor horsepower.

For example, suppose we have a 25-hp. motor at 1,160 r.p.m. full-load speed, from which we wish to drive a shaft at 280 r.p.m. Probably either a *B* belt or a *C* belt will be best. Let us assume the *B* belt with a 6-in. sheave. The table shows a speed of 1,800 f.p.m. for a 6-in. sheave on a 1,160 r.p.m. motor. At 1,800 f.p.m. the horsepower table gives 1.7 hp. for each belt of *B* section. Dividing 25 by 1.7 we find that we shall need 15 *B* belts to carry the load. The sheave on the lineshaft, by simple calculation, must be 24.86 in. in diameter.

Or, suppose we assume an 8-in. diameter driving sheave, and try the *C* section belt. The 8-in. sheave will give a belt speed of 2,430 f.p.m.

The corresponding horsepower, as per Table II, is 6.4 per belt. Dividing 25 by 4.6 gives 5 as the required number of belts of *C* section. Now we may choose whether to use 15 *B* belts with sheaves 6 in. and 24.86 in. in diameter, or to use 5 *C* belts with sheaves of 8-in. and 33.2 in. diameters. Or larger and fewer *D* section belts might be used. The selection will depend largely on local conditions or possibly the cost of installation.

The results given must be modified somewhat to offset certain factors that are met in many drives. The designer must determine the center to center distance between the driver and the driven sheaves. The V-belt drive is capable of operating on very short centers, and perhaps in a majority of cases it is this fact that leads many to use it. However, it will be seen that where the centers are shortened considerably there will be a smaller arc of contact on the driving sheave. The arcs of contact for both sheaves are found by the following formula:

Referring to Fig. 4,

$$K \text{ (approximate loss of arc)} = \frac{(y-x)\times(57)}{C}$$

$180 - K$ = arc of contact.

Having determined the arc of contact we amend the figures obtained previously to correspond with the following percentages. For,

180	deg.,	100	per	cent
170	"	98	"	"
160	"	95	"	"
150	"	90	"	"
140	"	85	"	"
130	"	80	"	"
120	"	75	"	"

The arc of contact should never be less than 120 deg., and the shortest distance between centers should always be greater than the diameter of the largest sheave.

Next the designer must further correct his figures to accommodate the kind of load to be handled. Pulsating loads and loads of high starting torque require a greater number of belts, the number of additional belts required being shown in the following list. Too many belts is an excellent fault always:

	Add Per Cent in Belts
Reversing service, like hoists	25
Ball mills, tube mills, rod mills	40
Sawmill machinery, band mills, resaws	25-40
Large fans and blowers	25-30
Pulp and paper mill machy	25
Air compressors and pumps	30
Textile machinery	50

The V-belt drive is undoubtedly the greatest development in transmission machinery since the advent of the steel split pulley. There is no question of its great future and when it has come to be as well known to plant operators its application will be as nearly universal as the electric motor.

TABLE II—HORSEPOWER OF V-BELTS AT VARIOUS SPEEDS

F.P.M.	A	B	C	D	E
1000	0.75	1.10	2.70	5.30	7.10
1500	1.00	1.20	3.70	7.60	10.40
2000	1.30	2.20	4.90	9.50	13.40
2500	1.75	2.65	6.00	11.90	16.50
3000	1.90	3.00	6.80	13.80	19.30
3500	2.10	3.50	7.75	15.30	20.20
4000	2.20	4.00	9.25	16.70	22.00
5000	2.20	4.10	9.50	16.80	22.30

TABLE I—BELT SPEEDS IN FEET PER MINUTE
For Usual Sizes of Motor Sheaves and Motor Speeds

Full Load Motor Speed	4"	4½"	5"	5½"	6"	6½"	7"	7½"	8"	8½"	9"	9½"	10"	11"	12"	13"	14"	15"	16"
690	723	804	904	995	1085	1175	1265	1355	1445	1535	1627	1716	1806	1987	2168	2348	2529	2710	2889
860	900	1012	1124	1275	1351	1465	1576	1689	1801	1914	2026	2139	2251	2477	2702	2927	3152	3377	3601
1160	1213	1363	1518	1670	1825	1975	2126	2278	2430	2581	2733	2885	3037	3340	3644	3948	4252	4555	4859
1750	1835	2060	2295	2520	2750	2980	3207	3436	3665	3894	4123	4352	4582	5040	5498	5946	6414	6872	7329

In One Plant–

64 APPLICATIONS *of* ELECTRIC HEAT

Concluding part of the article. The first part, published in the August issue, enumerated the types of work on which the electric furnace is employed and gave the reasons for the adoption of electric heat advanced by the engineers of the Union Switch & Signal Company, in whose plant are the installations described. It concluded with a description of the operation of a pit-type furnace used in the heat-treating department.

By WIRT S. SCOTT

Special Representative
Westinghouse Electric and Manufacturing Company
Mansfield, Ohio

THERE are three other electric furnaces in the heat-treating department: One hearth-type, 12x22x28 in., 8-kw., for blueing screws and other small parts at 600 deg. F.; also for hardening and tempering small tools and dies.

One hearth-type, 24x54x19 in., 45-kw., for carburizing and for the heat-treatment of large dies. Operating temperatures vary from 600 to 1,800 deg. F. The operating record for the greater part of one day is shown by the accompanying temperature control chart.

One cyanide pot, having a nickel-chromium vessel 17x17 in., 30-kw. capacity. The principal product case-hardened consists of cams requiring a certain portion to be hardened. The operating temperature is 1,550 deg. F. Sixteen cams are placed in a cyanide-chloride bath, consisting of 40 to 45 per cent cyanogen with the balance sodium chloride. Eight cams are put in and eight removed each 5 minutes, giving a 10-minute cycle. A skin case-hardening results. A 1/32-in. case can be obtained in three hours.

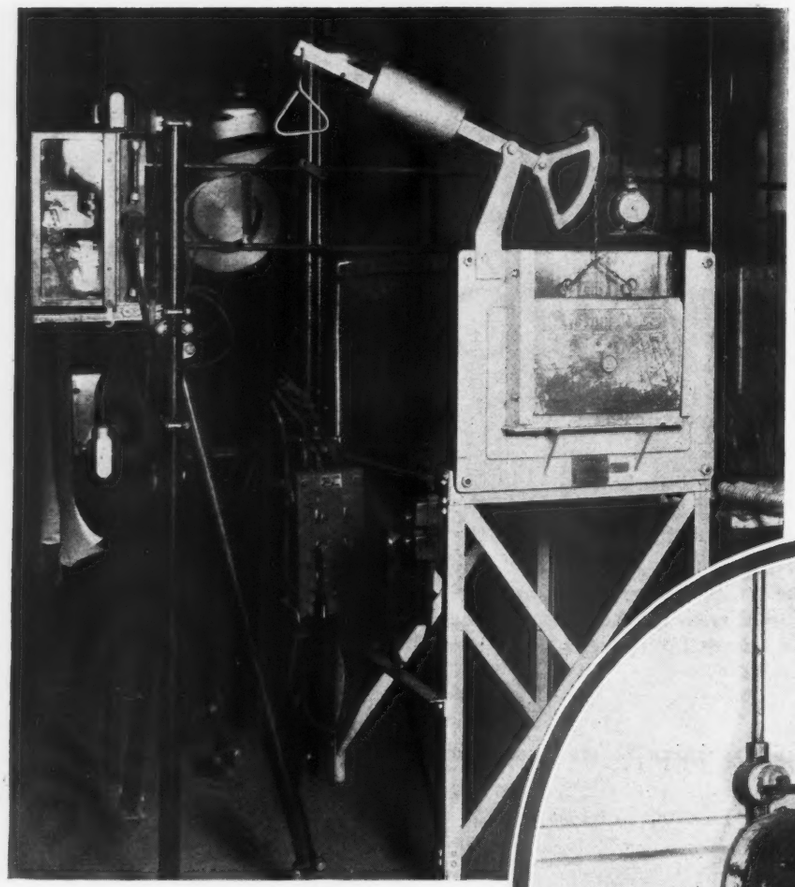
The 12x22x8-in. furnace is of the semi-muffled type, the heating elements being of the return-bend rod type, extending from the front to the rear of the furnace chamber, on both sides, top and bottom, and back of the perforated muffles. The bottom elements are protected by a cast nickel-chromium hearth plate.

The 24x54x19-in. furnace has open-type heating elements on the sides, with bottom elements under a heavy cast, nickel-chromium hearth. The side elements are suspended from alloy metal hooks anchored in the brickwork. Refractory guide blocks keep the turns of the elements separated and prevent short circuits. Heating elements are formed of heavy, nickel-chromium ribbon. Cast nickel-chromium alloy guards protect the heating elements from coming in contact with material during charging. A sand seal is provided at the top of the insulated door to reduce convection losses and provide greater uniformity of temperature.

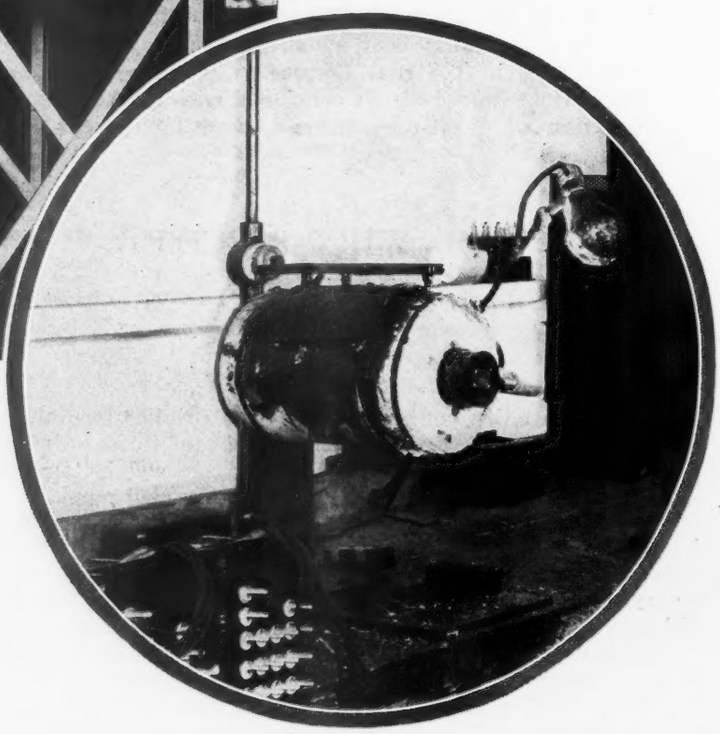
The cyanide pot referred to is provided with rod-type heating elements which surround the sides of the vessel in two concentric coils, giving not over 5 deg. temperature variation. The vessel has a wide flange to prevent molten material from getting down in the brickwork or heating elements. This furnace is operating at about 75 per cent of capacity and consumes approximately 7,600 kw.-hr. per month which, at 1c per kilowatt-hour, means a cost of $76 a month.

Each of the furnaces described is automatically controlled and is equipped with magnetic contactor, recording-controller pyrometer, and

A 30-kw. cyanide pot for case-hardening. Cams are receiving local hardening.



Furnaces of 17-kw. capacity used for oxidizing copper disks for rectifiers.



One of many electrically-heated compound kettles. Space heaters are clamped to the outer surface and are covered with insulation. A small thermostat maintains temperature.

Operation of the rectifier depends upon copper disks or washers, which permit the alternating current to flow in one direction only, thus absorbing one-half of the cycle and producing a pulsating direct current. This is accomplished by very carefully oxidizing the copper disks on one side only. The operation is performed in two 17-kw. furnaces, 12x36x8 in., and one 26-kw. furnace measuring 18x37x12 inches. The furnaces are each equipped with an alarm clock of special design which may be set to give an alarm at a predetermined time.

In the relay assembly department are three normalizing ovens, one of 5-kw. and two of 10-kw. capacity.

time clock for automatically starting the furnaces each morning so that by the time the heat-treaters arrive the furnace is up to operating temperature.

In the opinion of the heat-treating department these features make electric furnaces desirable:

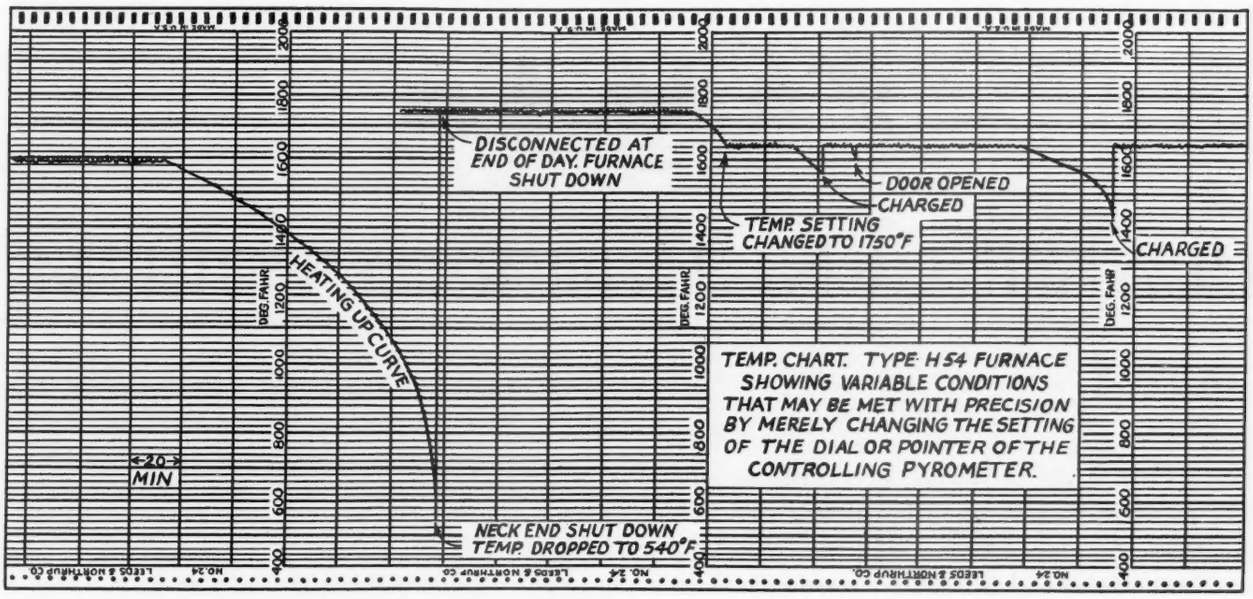
1. Ease of starting.
2. Furnaces up to temperature, ready for operation when the heat-treaters get on the job in the morning.
3. No attention to the furnace during operation.
4. Heat-treating reduced to definite time cycles.
5. Practically the entire hearth area is available for heat-treatment at the same temperature.

In the rectifier department there are three electric ovens and three electric furnaces, with girls and men working at benches within a few feet of them without any fear or discomfort. Parts of the rectifier are dipped in insulating varnish. Throughout the day the work is placed in the ovens, and during this time the varnish is receiving an air set. At 5 p.m. the doors are closed, the current is turned on, and the time clocks are set to disconnect the ovens at a predetermined time. Thermal protective devices cut off the current in the event of failure of the controlling thermostat. Graphic temperature charts show the temperature conditions in the ovens at all times. The baking is done entirely at night, without attention. The ovens measure 27x37x39 in., are rated at 14 kw., and are connected for three-phase, 60-cycle, 220-volt current.

These ovens are used for relieving strains in spring contact fingers. Adjustment during assembly may require further baking of the springs and reassembly, but the process has been justifiable because it insures that final adjustments will be permanent. The three ovens are operated 24 hours a day, at varying temperatures.

Coils used in connection with the signaling equipment are impregnated and then baked in an electric oven of 10-kw. capacity. Another oven of 80-kw. capacity is used for baking paint on metal parts.

Several 4-kw. ovens, with chamber 20x25x30 in., are interestingly applied. One is used for baking grid leaks valued at $450 per batch. The



Temperature curve of hearth-type furnace.

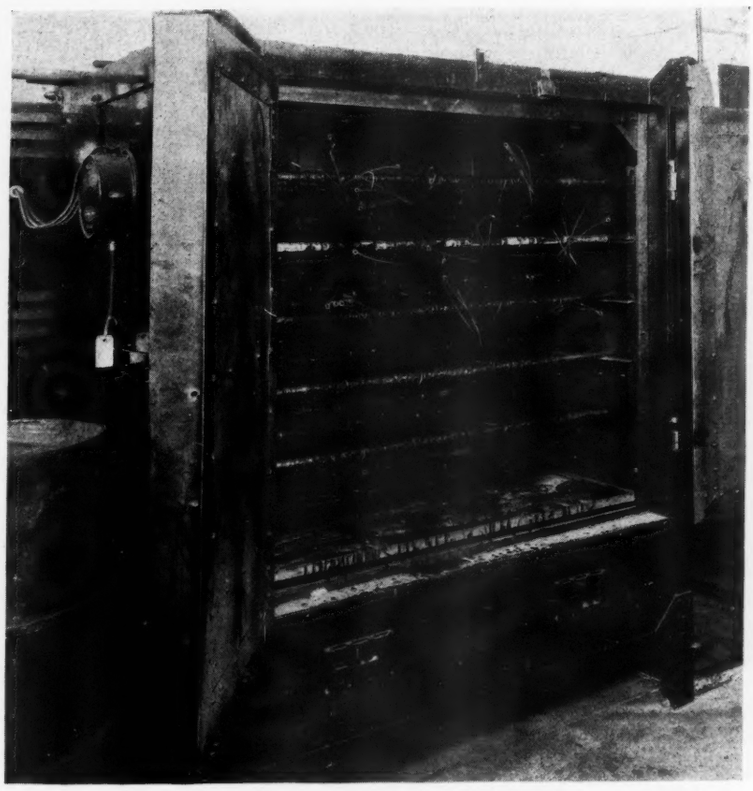
temperature must be held within 6 deg. minimum and maximum for 18 hours. A high temperature will cause a complete loss of the batch, and the necessary chemical change will not occur below a given temperature.

The research department is equipped with 17-kw. hearth-type furnaces, three 2-kw. laboratory furnaces, and two 1.5-kw. ovens. Scattered throughout the plant are a dozen or more compound pots or kettles of capacities varying from 500 to 5,000 watts, and approximately 25 solder pots of various sizes.

For a certain operation a special cement must be baked out at a temperature of 180 deg. F., and in an atmosphere of steam. A large garbage can was equipped with a funnel-shaped top. On the outside surface six 1-kw. space heaters were clamped, and some insulation was placed over them. About ½ gal. of water in the can produces a fog at just the right temperature.

The equipment indicated in the following list shows the extent to which the Union Switch & Signal Company uses electric heat.

Heat-Treating Department	
1 pit-type furnace	75 kw.
1 hearth-type furnace, 12x 22x8 in.	8 "
1 hearth-type furnace, 25x 54x19 in.	45 "
1 cyanide pot, 17x17 in.	30 "
Rectifier Department	
3 ovens, 27x37x39 in.	42 kw.
2 furnaces, 12x36x8 in.	34 "
1 furnace, 18x37x12 in.	26 "
Relay Department	
1 normalizing oven	5 kw.
2 normalizing ovens	20 "
Research Department	
2 hearth-type furnaces	34 "
1 oven	4 "
3 laboratory furnaces	6 "
2 laboratory ovens	3 "
Miscellaneous Departments	
3 ovens	12 kw.
12 compound kettles, space heaters	30 "
25 solder pots	50 "
1 paint drying oven, oven heaters	80 "
1 coil baking oven, oven heaters	10 "
1 steam kettle, space heaters	6 "
Total number of pieces of electrically heated equipment	64
Total kw. capacity	520



Baking varnish on rectifier parts. Each of the three ovens used has a capacity of 14 kilowatts.

PLANT • ENGINEERS' • FORUM

* * *

Here is the thirteenth of a series of questions, each of which has at least two sides. A new question will be presented next month, and our readers' answers to previous questions also will be published. Write down your opinions and send them to the editor. Answers published will be paid for at an attractive rate.

* * *

What Maintenance Policy During Depression?

Frank Fulleger and George Shipman have been invited for a Sunday morning of golf at the Oneida course. In these days the forty-mile drive they must make to get there is only an added inducement. As the scene opens they are pounding along at from 50 to 60, and talking of this and that. As we begin to listen in George is just finishing an enthusiastic account of his vacation doings. He concludes by asking Frank when he is going to take his vacation.

* * *

"In the winter, as usual, George."

"Does that mean that you are strong for winter sports, Frank—or just different? Summer is vacation time, you know."

"I'm surprised at such a question from you, George. You know as well as I do that during the summer slump we have to prepare for winter production."

"Yes, that's so, unless you keep up with your maintenance work the year round. If you do, it ought not make much difference when you go."

"In theory that's all right, George. But take our condition right now, for example. With us, as with most plants, 1929 was a boom year. Time after time we decided to let some needed improvement go by rather than slow down our output. I'm referring to the equipment itself. We wanted to change certain mechanical drives; then there was a lot of control equipment we wanted to improve; we scheduled a scad of motors for replacement; lighting was to be bettered; there was certain piping to go in; you know the paint job we've been doing. I could take you through the whole plant conversationally and even you would be surprised at the changes we are making."

"But the summer is pretty well gone now, Frank. Didn't you have all the new stuff ready?—and didn't you begin this job last March or April?"

"No, and yes. We thought we were pretty well covered with new equipment and replacement parts. But when we came to doing the job we enlarged the program. Found that things could be bought at lower prices, that some mighty fine mechanics of the kind we have been short on were available, that the equipment and labor situation was entirely in our favor."

"Still, that was months ago, Frank."

"Yes, but give me a chance. We found all this out, and then—well, there's the sad part of the story—our management wavered. Seemed to be in a funk. Things looked so bad that they hesitated to spend *any* money. Took 'em three months to get back their courage, and the result is that right now the maintenance department is up to its neck. For that matter we're still selecting equipment for which orders won't be placed until business actually does pick up."

"And in the meantime?"

"In the meantime we're getting all set to break records in putting the new stuff in. And you ought to see what we've done up to date!"

"I'm going to visit you, boy—I'm anxious to see just what you have done. And I approve of your winter vacation idea. I'm strong for steady maintenance, but I see what you were up against. We're getting close to Oneida and had better begin to think golf."

* * *

Frank and George agree for once! But then they haven't said all they might have said on this important subject. Perhaps some readers of INDUSTRIAL ENGINEERING *disagree with them. Probably other readers feel that some of the most important reasons in favor of Frank's procedure have not been brought out. Have you pen and paper? Let the editor have your opinion.*

During depression shall we prepare for the production that is ahead? Why or why not? What are the things to be done?

(Answers to previous questions start on the following page)

READERS' ANSWERS

to previous questions

Do Centralized or Decentralized Stores Better Serve Maintenance?

(Question presented in the August issue)

WE certainly must have some semblance of system if we are to know just where we stand. If each unit of the works is to handle its own storekeeping the inevitable result must be chaos.

In a case such as the one presented why not do as one of our larger eastern manufacturers has done, much to his advantage? The stores department handles the majority of the stock for repairs, but exception is made of certain articles that are extremely hard to procure on short notice. These items are carried in the department itself, and the department is held responsible.

The department heads went over possible requirements and, with the objective of covering for all contingencies, decided just what material would cause a serious tieup if not obtainable. These materials were ordered and placed at the command of the department heads who had to maintain them. This system has been in operation for three years and has never failed. The small amount of stock ordered for emergency was surprising. The only guide was past performance and knowledge of the job. It would be ridiculous to stock pipe fittings and other parts that are obtainable at a minute's notice in any place except the stores department.

CHARLES R. WHITEHOUSE, *Standards Engineer*
The Holtzer-Cabot Electric Company
Boston, Mass.

THERE are, no doubt, many things to be said on both sides of this question but when all things have been considered, the correct solution is the central store. Naturally there will be minor difficulties arising from time to time; such as a lack of certain necessary parts just when needed for emergencies, but this would also take place occasionally if each department had its own storeroom.

The storekeeper's job is important and a working knowledge of the needs of each department in the plant is required of the storekeeper. The storeroom must stand ready to supply hundreds of necessary parts at a moment's notice and splitting up the storeroom into dozens of locations under dozens of department heads only increases confusion, adds to the overhead, duplicates effort, increases waste, and increases the inventory of stock. If every Tom, Dick and Harry in the plant is to carry his own stock he is just as likely to be short of badly needed repair parts as is a central storeroom.

CHAS. A. PETERSON, *Master Mechanic*
Cold Spring Granite Company
Cold Spring, Minn.

I FORMERLY worked for the Public Service Coordinated Transport, a company operating street cars and buses.

Because of the large area covered it was necessary to have a large central storeroom, with smaller storerooms in the individual car houses and garages, with the exception of the Maintenance of Way Department, which had only two store departments, one for the Northern Division and one for the Southern Division.

A supply truck made the rounds of car houses and garages once a week. The truck came to the same car house or garage the same day every week. Previous to that day the foreman in charge of each car house or garage made a requisition on the general storekeeper for his week's supply of material.

In the case of a plant where the entire shop is on one floor I believe one storeroom is sufficient; but for larger plants, I recommend a system similar to the one I have described, that is, a main storeroom with general storekeeper in charge, with separate storerooms for the departments with storekeepers reporting to the general storekeeper.

This system would be in effect what Frank desires but would keep the stores under the stores department where it should be.

J. WALTER WRIGHT, *Assistant to the President*
Wilmot Fleming Iron & Steel Company
Philadelphia, Pa.

Do Distributors Serve Industry Economically?

(Question presented in the June issue)

A DIRECT answer to the above question is: "Up to a certain point, yes; beyond that point, no." A mill supply house has its place in the sun just as does any other legitimate business, and is in many cases a boon to the mill maintenance department. The mill supply houses have representatives covering the various industries periodically, and these men soon learn from experience what lines are most needed and most urgently needed; they can anticipate the demand, and carry the lines that will enable them to serve at a moment's notice. By many years' experience it has been proved beyond doubt that quicker service can be had through supply houses than from the manufacturers direct.

In some cases the manufacturer of a few specific lines may give as good service as the supply house but, as a general rule, no better.

When it comes to purchasing machinery that requires factory service and erection, it is best to purchase from the manufacturer.

Jobbers handling motors, engines, elevators, and

heavy mill and mining equipment are able to give any operating information as well as service. In the matter of information, the jobber has a distinct advantage because in all cities and medium-sized towns he has a representative on the job all the time; whereas a representative from the manufacturer is required to make a special and sometimes lengthy trip.

Prices average the same whether equipment is purchased through the jobber or direct from the manufacturer, since the jobber is accorded that protection for his service by the manufacturer. In cases where a special discount is given for an extremely large order, buying from the manufacturer direct will create a considerable saving, but these cases are special and have nothing to do with the usual run of orders.

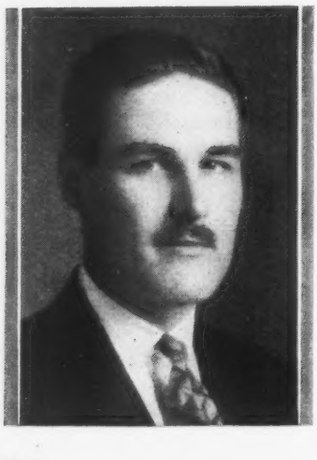
My experience may be summed up in this way: I have purchased from both sources, in certain lines, particularly motor and control equipment. I have had satisfactory dealings direct from the manufacturers who, in two cases at least, have no jobbers. Repair equipment for the above apparatus is also purchased direct and, with the exception of a very few cases, the service has been all that could be expected.

In the purchase of miscellaneous repair apparatus and material the jobber has rendered better service in a number of cases than the manufacturer and in several cases, when inquiries have been made, I have been referred to the jobber by the manufacturer.

One outstanding instance was where a carload of equipment was purchased from a jobber who was in position to switch a car that was loaded for another customer, who was not in a hurry, direct to us, thus saving over a week in delivery, which would not have been possible had the purchase been made direct from the manufacturer.

H. E. STAFFORD, *Electrical Engineer,*
Port Arthur, Ont.

AS a result of personal experience and contact I have gradually placed all distributors, within my own mind, in two classes. In one group are found those who do not limit themselves to carrying equipment covering a certain field but endeavor to distribute anything that has sales possibilities. This type, I believe, is a detriment to industry because the selling objective is so overwhelming that the greater issue of service, upon which the real success of a distributor is built, is secondary. Distributors fitting this description are defeating their own ends and are becoming fewer.



W. B. FERGUSON
Works Electrical Engineer, Westinghouse Air Brake Company, Wilmerding, Pa., has contributed to the Forum.

In the other classes are found those that are specialists within a certain field, such as mill house, electrical, tool and kindred supplies. This type of house has the backing of the manufacturer and renders a real service to industry. Its very existence depends upon the thoroughness with which this service is rendered.

One of the most important contributions of the real distributor is that of prompt deliveries. A study of the area served and its needs acquaints him with what to carry that equipment and supplies may be delivered from stock. The readers undoubtedly know well of instances where much time and money were saved because a particular size and type of belting, or brand of steel, or kind of paint, or what not, could be picked up almost immediately through the local distributor.

A dealer of the second class mentioned will in most cases be willing to carry practically any item if he has assurance that there will be a demand for it. Thus, in addition to prompt delivery service, there is a warehouse and inventory service.

Many times there arises the question as to whether equipment or method can be adapted. If the problem must be taken up with the manufacturer there is endless correspondence with the possibility of misunderstanding in the end—or there are traveling or other expenses involved. Where a reliable distributor can handle such details great saving can be made. Arrangements for trials can be made and followed up.

Distributors make possible a personal relation between manufacturer and consumer and much of value can be learned as to operating conditions in the same and other industries.

With most reliable manufacturers there is little or no difference in cost of equipment and supplies, whether purchased from distributor or manufacturer. For the most part standard price lists are adhered to subject to discounts for the various classifications. What difference exists usually is more than offset by the value of distributor service.

H. L. SCHULTZ
Assistant Superintendent of Maintenance
The Carborundum Company
Niagara Falls, N. Y.

YEARS ago, when industry was not changing rapidly, and scientific management methods were not applied by so many users, distributors may have served industry economically. During that time the general problem of distribution remained the same and distributors had to stay.

But progress is the base of our business today. The combination of small businesses to form larger units has proceeded rapidly in the last five years. There are no signs that this movement is to be retarded seriously.

The trend is toward merging distribution facilities as a relief from economic pressure. It is a trend in the direction of vertical merging under one management, with two outstanding problems, manufacturing and distribution. Changes in distribution methods must proceed slowly, for no changes can be made successfully without cooperation of buyers and sellers. The buyers have to be in favor of a new system that drops the distributors. But economic laws will put it through.

It must be admitted that there is a tremendous waste of energy and money in the distribution system of

today. If that waste is eliminated prices will be lowered and thus the buying power of the user will be increased.

Distribution costs consist of direct selling expense, that is, (1) salesman's salary and expense; (2) administration; (3) advertising; (4) market analysis; (5) purchasing; (6) cost of housing merchandise; (7) handling the orders; (8) the clerical expense of billing. It is not hard to see that in the performance of 2, 3, 4, 5, 6, 7 and 8 much energy and money are wasted if a mill supply house stands between manufacturer and consumer. A great deal of work is done once more by the distributors after it has been done by the manufacturer. In addition, the manufacturer wants to know why he should continue to give the distributors the same old discount if he must do so much of the distributor's sales work. He has often turned to direct selling and dropped the distributors with good results.

Do mill supply houses render economical service by the carrying of inventory and supplying on emergency? Considering the facts of our business trend we must say no. For modern scientific management methods don't need this kind of service. Only those buyers who do not know how to manage their plants under up-to-date rules need it.

Good management is planning ahead, even to final details. The expense of repairs and costs of plant development, improvement, and upkeep are carefully budgeted. Every plant ought to have a definite policy to forecast its needs for a certain period. Budgeting in connection with proper inspection makes it easy to place orders with the manufacturer for prompt delivery. Why support buyers with outmoded management methods? It is absurd to do that in our progressive business age. Any support that protects inefficiency in manufacturing and distribution methods does an injustice ultimately to the general public.

The census of distribution, the industrial census, particularly, will bring out some views of this problem that were never thought of before, if we look at the figures from that angle. It will not entirely solve the problem, but we shall be working with distribution from a different perspective. F. J. WOLF, *Mechanical Engineer*
Homestead, Pa.

DISTRIBUTION and service as rendered by the equipment manufacturer are of vital importance to operating men and plant engineers. There are three methods: The sale of equipment direct by the large manufacturer who is his own distributor and jobber as well as service engineer; the distribution of specialties of the larger type, such as condensers, pumps, engines, turbines, and large gear reductions, where sales engineers specialize on distribution but do not furnish stock or warehouse services; and sale by the mill supply distributor who carries a long line of stock and renders warehouse service as well as engineering advice to us customers. It is with the third method that this discussion deals. I feel that the mill supply house is a vital link in the chain and fills an economic function for those who are purchasing equipment. The customer appreciates the services rendered and feels that he is paying a well-earned profit to the distributor.

A distributor must not force on the market items that may render him a larger profit than will those of superior quality. Customers quickly sense such

MERLYN F. STEPHENS
Industrial Engineer, Precision Castings Company, Inc., Fayetteville, N. Y.; one of the active followers of Frank Fulleger and George Shipman.

action and frequently will change jobbers in order to obtain quality equipment at correct prices.

The mill supply house carries such a complete line of equipment that its salesmen unconsciously stress the advantages of certain lines that appeal to them. It is perfectly natural to do so but is not always fair to the customer. The salesman for a mill supply house must be open-minded in his recommendations. Manufacturers must send good sales engineers to supplement the men furnished by the mill supply house to assist in bringing out technical information on special problems.

Delivery is of vital importance, especially to the maintenance engineer. Most plants maintain a reasonable supply of spare parts in their warehouses, but depend on the distribution centers for their main source of supply; unless they can obtain quick delivery they are handicapped in making emergency repairs. They frequently are willing to pay the additional cost of fast handling in order to insure continuity of production.

The only way to build up good will and maintain constant sales is through the interest of the distributor's salesman. He must keep in close contact with the customer by frequent calls; he must keep the customer acquainted with developments to insure him the service that brings repeat business.

Warehouse and inventory service is of vital importance, especially under existing methods of business where manufacturers are keeping their inventory at minimum. A considerable stock on the distributor's shelves is required, but a service is being given the customer, who appreciates quick action and will do business with those who can furnish equipment at an instant's notice.

Many operating men have been helped appreciably by the information rendered through the representatives of the distributor. These men are traveling about the country and are constantly in touch with practices developed by other plant engineers. Such information, although it may be specialized, frequently can be employed under different conditions. The smaller plant depends largely on the engineering advice furnished by the distributing houses. Concerns that maintain resident engineers find that by exchanging ideas between organizations improvement in application is developed.

Many companies endeavor to purchase supplies direct from the manufacturer, especially when buying in large quantities. This procedure is sometimes justified, but I feel that the small percentage gained by saving

the dealer's discount is more than offset through the loss of good will and services which are rendered by the distributor in times of emergency. I believe that if a customer has a large order to place he should give his regular distributor the benefit of this order in the interest of future emergency service.

When large orders are involved it sometimes pays to tell the distributor frankly that you expect a lower discount in view of the amount of business. Frequently he will feel justified in giving the customer the larger discount.

I have had experience in buying from both sources. When buying an engine, a large motor, a boiler, or other specialized apparatus, I prefer to deal direct with the manufacturer or his immediate representative. When purchasing standard equipment, such as shafting, hangers, pulleys, belting, and anti-friction bearings, it is good business to deal with the local distributor. The distributor appreciates this point of view and will render service in speed of operation and in furnishing information that will more than offset his percentage in handling transactions.

K. D. HAMILTON, *Mechanical Department*
Geo. E. Keith Company
Campello, Brockton, Mass.

GEORGE and Frank have succeeded in stirring up a question that long has been a bone of contention. In all fairness to the manufacturer, the distributor, and the buyer, I believe we should all take the distributor's part in the argument.

What is more important than the speedy delivery of repair parts when machines are tied up, stopping production and sometimes causing the layoff of the operator, which quite often results in losing a good man? This kind of service cannot be gotten from the manufacturer, as he in most cases is located at too great a distance. Is it fair to use the distributor only when in a hurry, and to forget him and place your other orders direct? Let us not forget that he does not get his profit from the occasional order but from the steady flow of business, and if he is not properly supported he will have to quit; then to whom shall we turn when in a pinch?

As to the distributors' salesmen, where are there any men in the trade that are more expertly posted on the trends of the market, values of supplies, and sundry information which they accumulate during their travels, which they are always ready to dispense at no cost? Where can we get the most up-to-date information on what the other fellow is doing to speed up his production and decrease his costs; on the latest types of machinery or attachments for the machines in use, that will materially benefit us? If there is any specific information required is it not easier to call up the distributor's salesman and get it, rather than write a letter and wait a week or more for the answer?

Sometimes the price when buying direct is slightly lower, but take the savings so accumulated and compare them with what the costs on hurry jobs would have been if there were no distributor and the question will answer itself in a startling manner.

I do not base my argument on the theory of live and let live, but on the principle of what is safest and most economical for all the parties concerned. It will be a sorry day for us when the distributor goes out of business; which I do not believe can happen, as most manufacturers with a good reputation protect the interests of their distributors by giving them their margin of profit on all direct sales made in their territories. This is as it should be, for who has built up the contact? Certainly not the manufacturer.

CHARLES R. WHITEHOUSE, *Standards Department*
The Holtzer-Cabot Electric Company
Boston, Mass.

MANUFACTURERS are only human. If they get the bulk of their orders direct from the user how long will they continue to sell through distributors? And if the distributors disappear, what will the user do in an emergency? Where will he get the personal and engineering services that he now gets from the industrial distributor? Thus the old question of the advantages and disadvantages of the elimination of the middlemen is brought up.

In this connection particular attention has been directed to the supposed advantages arising from the elimination of the middleman. Obviously, if the middleman is eliminated it will be necessary for producers of goods to deal with the consumer. Yet experience has shown that in many cases the price to the consumer cannot be reduced in this manner. As a result of the increasing division of labor and the more definite specialization of functions in industry, the middleman has arisen to fill an economic need. His task is to bring together the consumer and the producer of goods. His one function is to sell. He has specialized on marketing problems. In many instances he removes from the producer the very great risk which might otherwise be incurred through selling to a large and miscellaneous assortment of consumers. The producer frequently finds that the division of interests and the increased expense which result from direct distribution may become a serious financial handicap.

This problem has been and will continue to be the subject of much speculative discussion. In most cases, however, it is rather difficult to demonstrate that any actual saving has resulted to the producer from the adoption of this method. It is still more difficult to ascertain that the ultimate consumer, in whose welfare the theorist is most interested, gains anything whatever from the practice. Even though there should be a reduction in the costs of distribution in this manner there is no assurance that the consumer will immediately be the gainer. Much will depend upon the type of commodity marketed, and the extent of the monopoly in distribution which may result through the control of the channels of trade by associations of producers.

Waiving the financial consideration involved in the elimination of the middlemen, whose industrial existence is due to the fact that they perform a most important economic function, it is undoubtedly true that the costs of distribution might be greatly lowered through the elimination of many expenses which are obviously largely the result of competition in selling.

Some of the advantages to be considered in buying from the distributor are: First, the close contact with the distributor's salesmen leads to the dissemination of helpful information; second, prompt delivery is assured when purchases are made from a distributor, because he keeps parts or inventory in his warehouse for the users' emergencies; third, the personal and engineering service that the distributor offers offsets any saving made by buying from the manufacturer direct.

HARRY KAUFMAN, *Engineering Department*
Naval Aircraft Factory
Philadelphia, Pa.

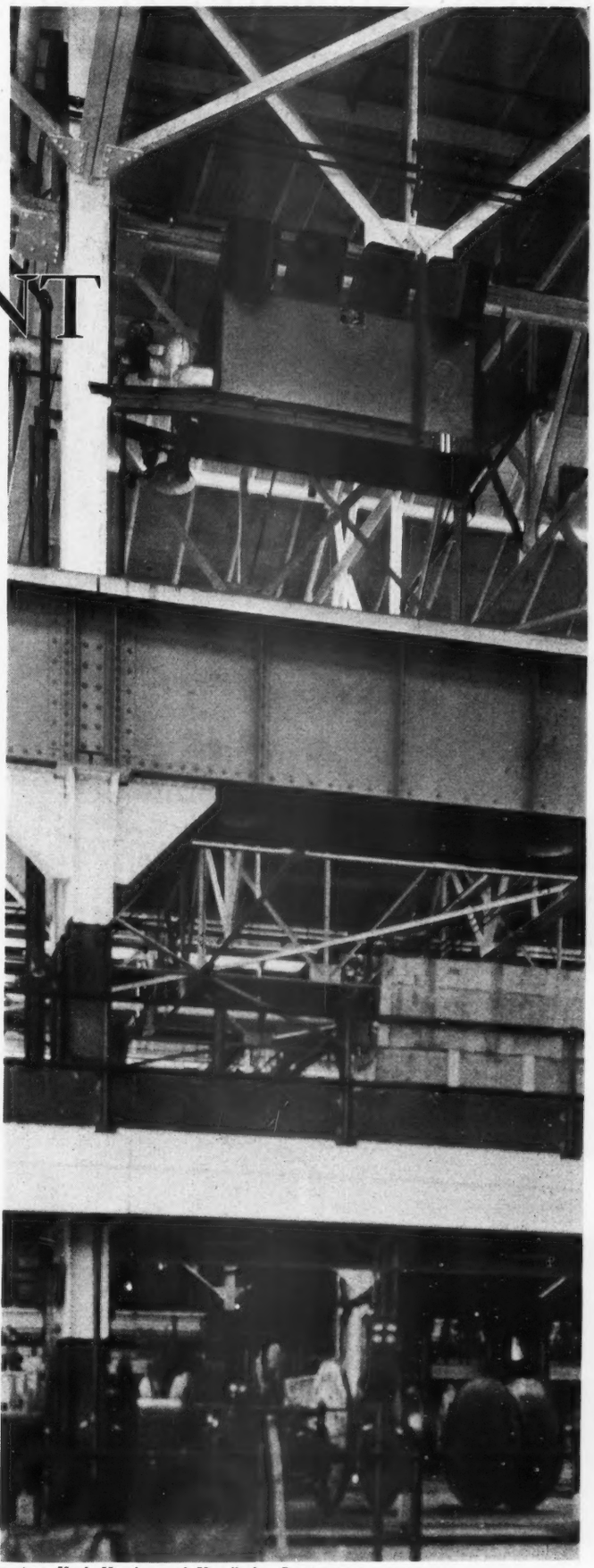
MODERN EQUIPMENT AT WORK

SHOWING that modern equipment IS at work has been a pleasant task. We are gratified at the reception given our exposition.

In the July Modernization Issue a hundred and forty pictures showed applications of modern equipment in plants located in more than twenty states and manufacturing some sixty kinds of products.

Last month we published twenty-three pictures in the section "Modern Equipment at Work," adding to the number of states and kinds of products represented.

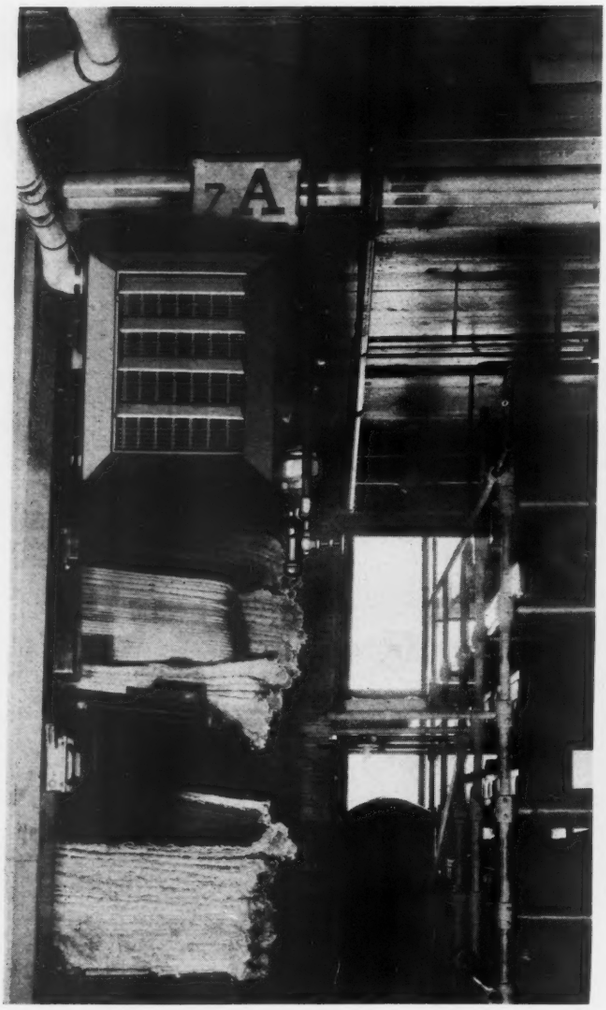
And here are additional pictures, still further enlarging the story. Modern equipment IS at work and more of it is being put to work all the time in preparation for production at lower cost.



Suspended type of unit heater in the Point Breeze, Md., plant of the Western Electric Company. 9,750 cu. ft. per min.; 1½-hp. motor at 870 r.p.m. Building heat, 60 deg. Thermostatic control.

Courtesy York Heating and Ventilating Company

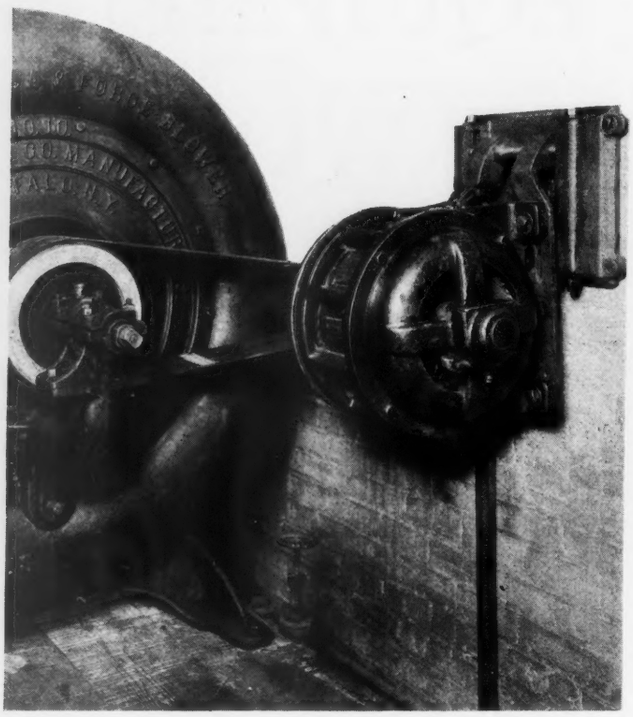
MODERN EQUIPMENT AT WORK



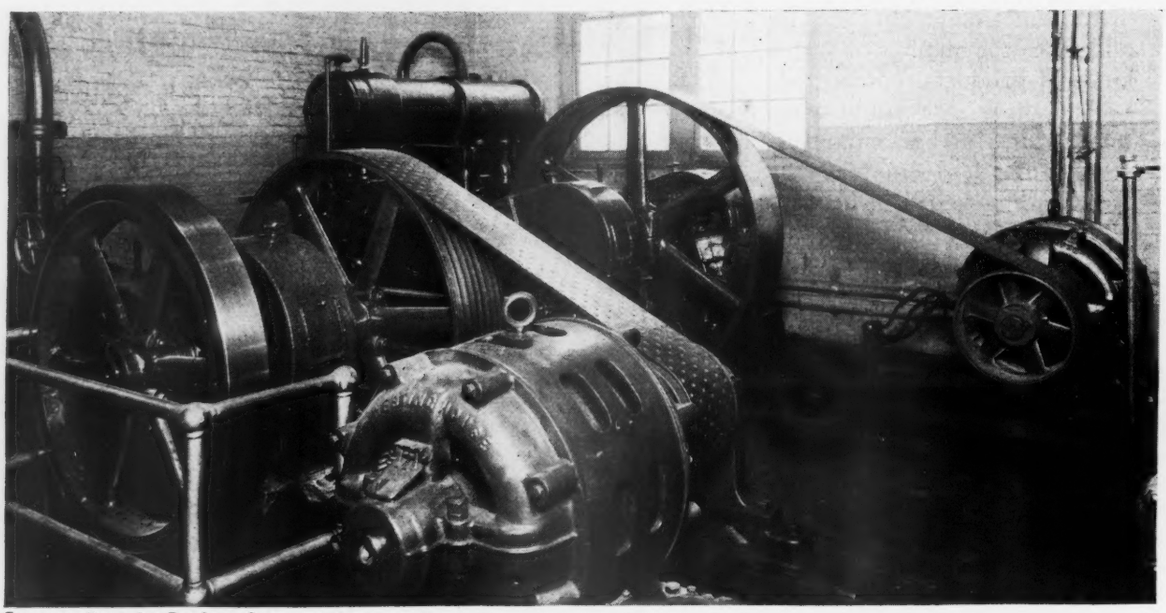
Unit heater installation in the stock room of the American Laundry Machinery Company, Chicago, Ill. Thermostatic control winter and summer (the fan is used for air circulation during hot weather).

Courtesy Autovent Fan and Blower Company

Pivoted motor base makes possible constant belt tension. Distance between centers is 22 inches.

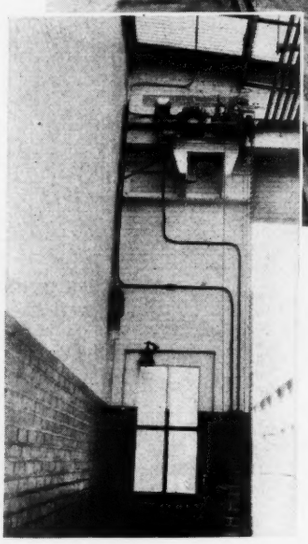


Courtesy Rockwood Manufacturing Company



Courtesy Alexander Brothers, Inc.

Two 75-hp. compressor drives in the plant of the Crown Cork & Seal Company, Baltimore, Md. Both employ belts of special construction. One is 10-in. double with 58-in. centers; the other is 12-in. double with 80-in. centers.



National Cash Register Company's loading and unloading platform for raw stock, scrap, and machinery. Entirely inclosed, steam heated, door motor-operated.

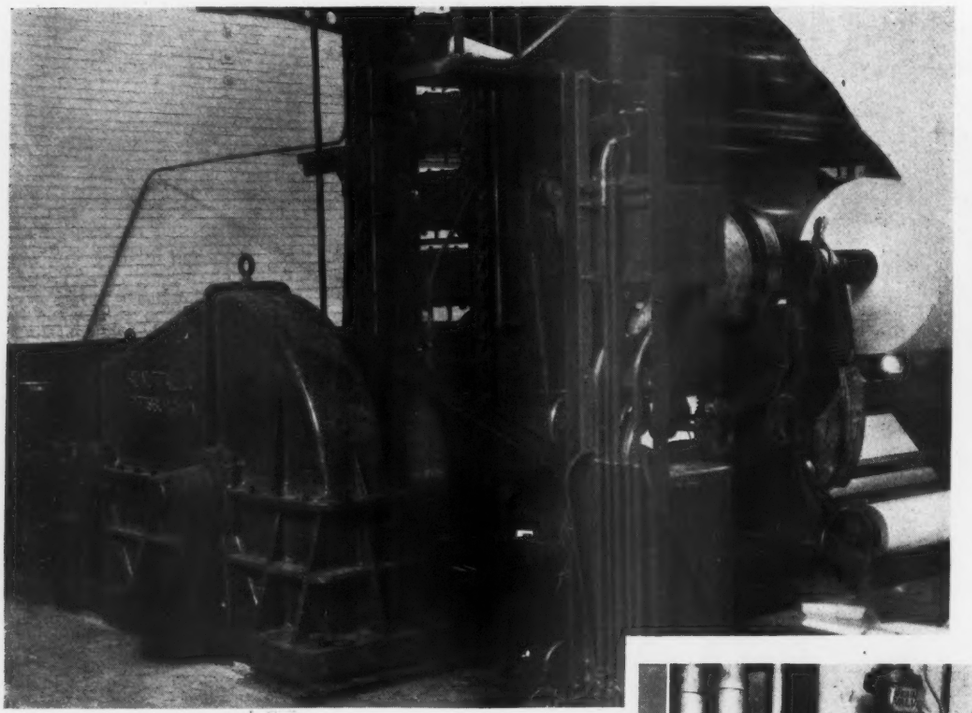
Lift truck, lift truck platform and stacker, used in combination, make easy the tiering of heavy loads. The stacker is of 3,000-lb. capacity, with hinges and with pushbutton control on the carriage and at the base. Safety device prevents dropping of load.

Courtesy The Lewis-Shepard Company

Courtesy Johnson Fan and Blower Company

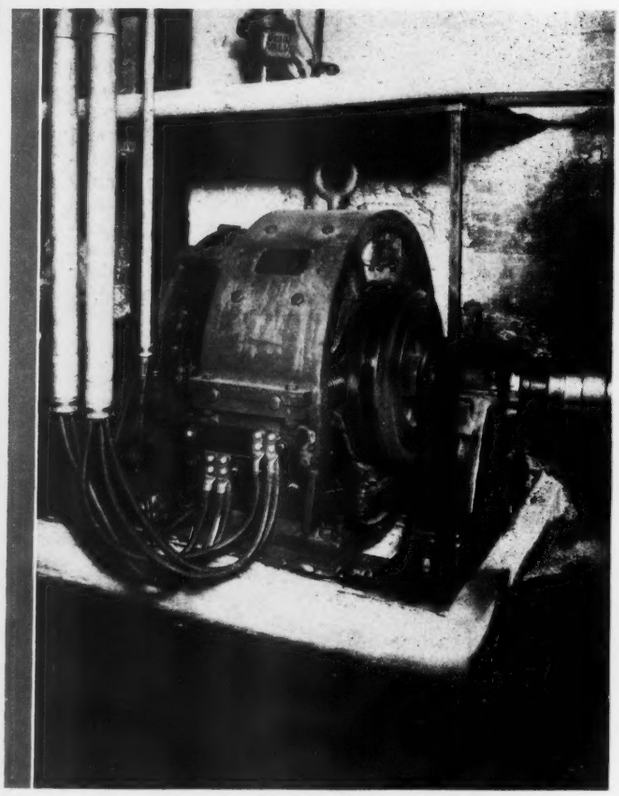
Unit heater built behind the wall and heating one-half of the front of the general offices, an area of 5,102 square feet—plant of the John Baumgarth Company, South Bend, Ind.

MODERN EQUIPMENT AT WORK



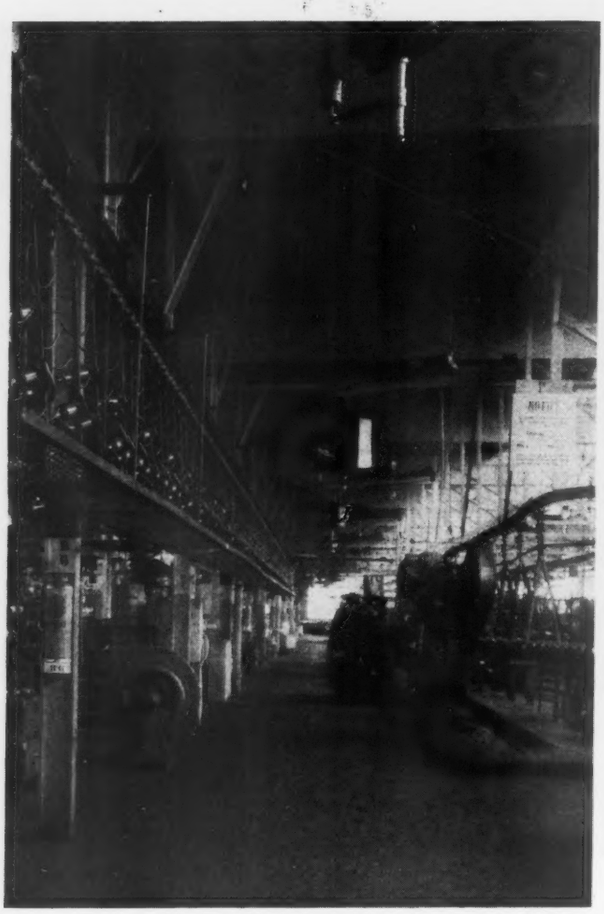
The S. D. Warren Paper Company, Cumberland Mills, Me., by using a single - reduction gear having long center distance, was able to locate motor and super-calender on the same side of the gear unit to conserve space.

Courtesy Westinghouse Electric & Manufacturing Company, Nuttall Works



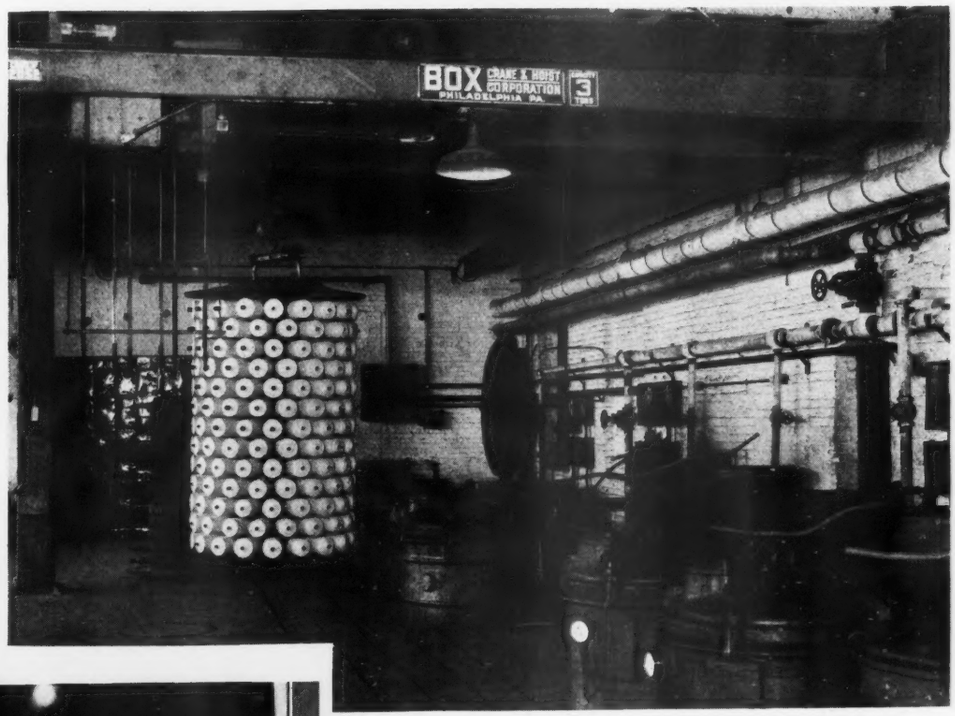
Courtesy Westinghouse Electric & Manufacturing Company

Three hundred horsepower at the shaft of a single-motored paper machine, the speed of which is held constant despite load fluctuations by a combination of variable voltage and field control.



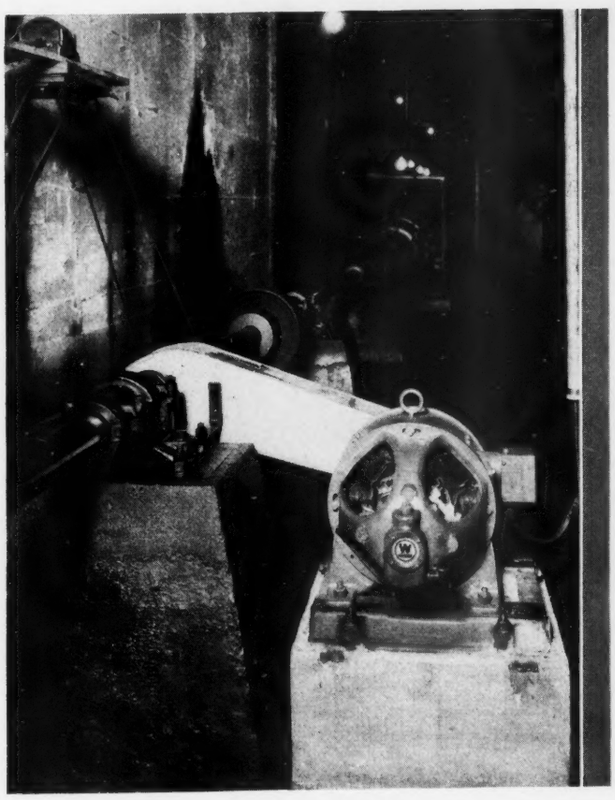
Courtesy Air-Way Electric Appliance Corporation

The Electric Auto Lite Company uses unit heaters in its Toledo, Ohio, plant.



Electric traveling crane arranged to operate on the lower flanges of two I-beams, thus permitting the hook to be elevated to within 17 in. of the ceiling. The equipment is used by the Ontario Dyeing Company, Philadelphia, Pa., to handle rayon to and from dyeing retorts.

Courtesy Box Crane & Hoist Corporation



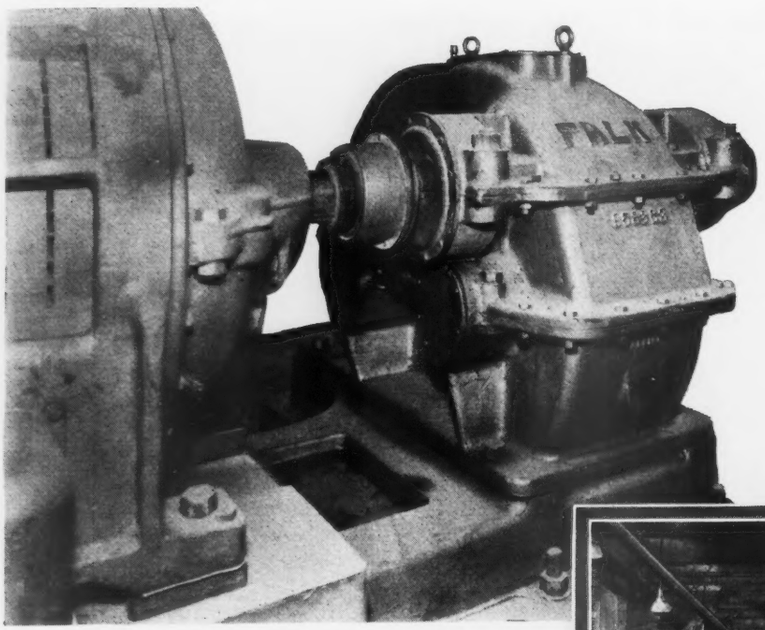
Courtesy Westinghouse Electric & Manufacturing Company

Part of remote, speed-control devices for the paper machine drive. A pilot generator, chain driven, maintaining a constant paper speed from no load to full load.

It's any plant's job to load and unload. The Goodyear-Wende Oil Corporation, Buffalo, uses a lifter and one man instead of a ramp and two or three men. It's safer.

Courtesy Economy Engineering Company

MODERN EQUIPMENT AT WORK

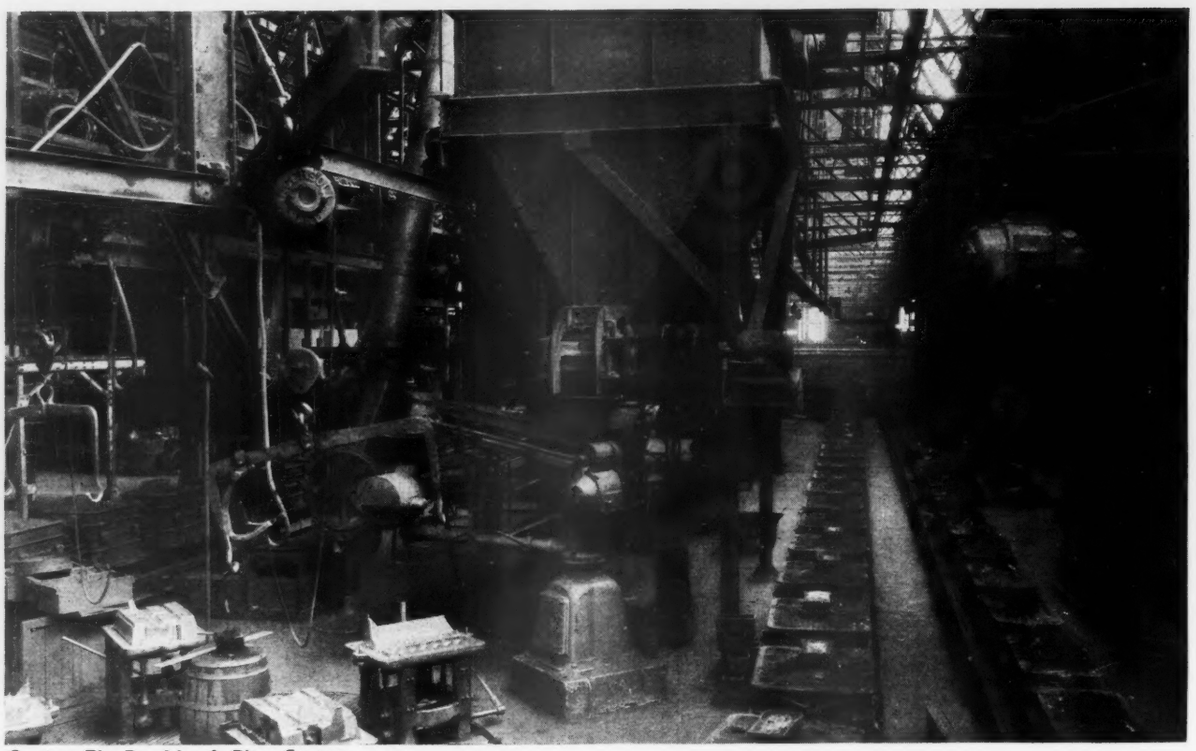


In the Nisbet plant of the Eastern Grain Elevator Company, of Buffalo. A speed reducer with a 25.8 to 1 ratio, driving a house lofter. The motor horsepower is 150.

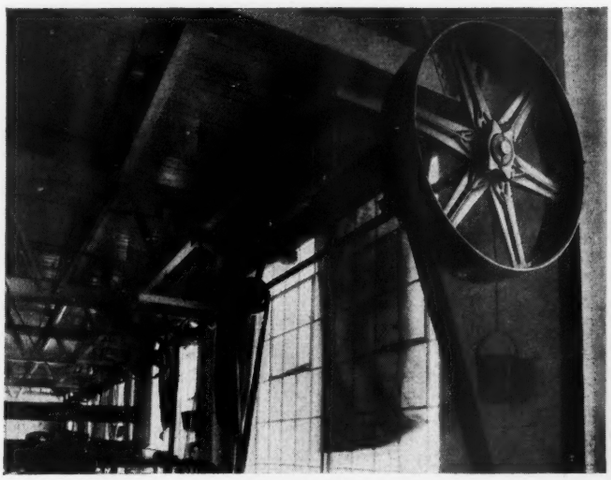
Courtesy The Falk Corporation

Twelve 5-hp. motors are used here in the assembly and run-off department of the Cincinnati Shaper Company, each machine thus having its own driving motor. The same system is used on the final inspection floor.

Materials handling equipment such as pictured brought production of the Nash Motors Company, Kenosha, Wis., from 100 tons to 290 tons of castings per day, with constant floor space of 20,900 square feet.

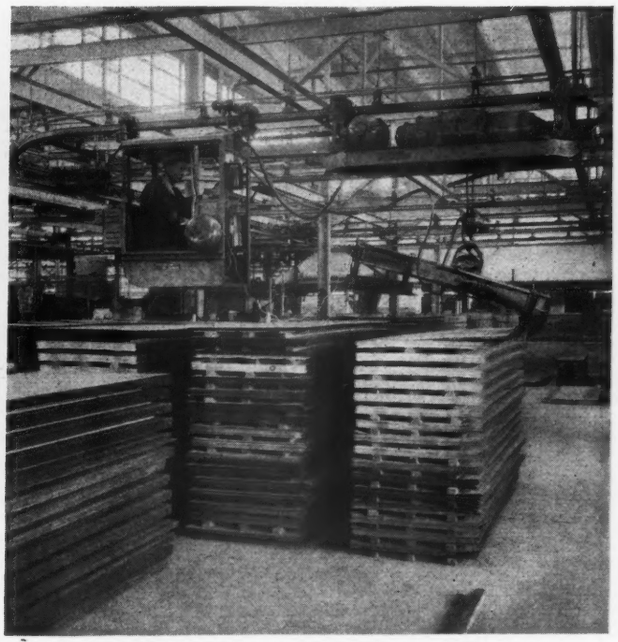


Courtesy The Beardsley & Piper Company



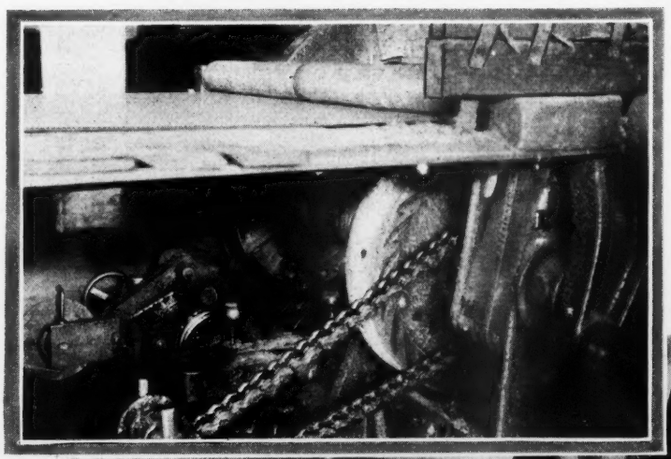
Courtesy S K F Industries, Inc.

$1.99 per hanger per year, initial cost plus interest, plus maintenance is the estimated cost over a 25-year period of these ball-bearing hangers—in use in the plant of the L. H. Gilmer Company, Philadelphia, Pa.

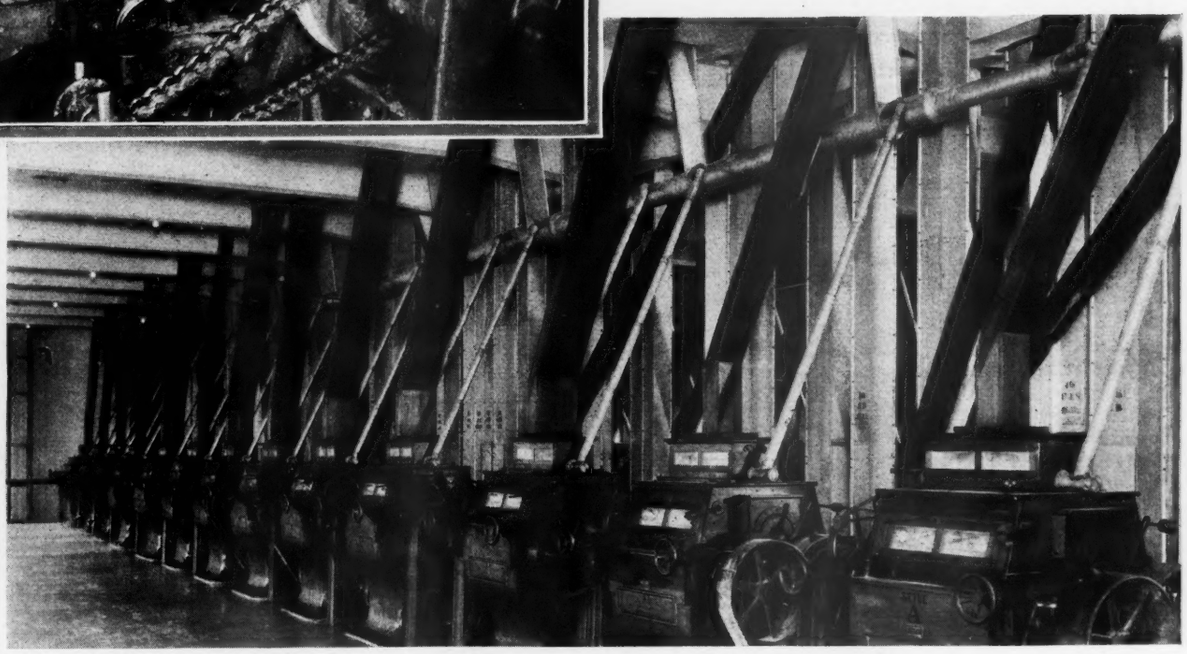


Courtesy Cleveland Crane & Engineering Company

With this equipment the operator moves material in a hurry at the plant of the Leonard Refrigerator Company, Grand Rapids, Mich. The operator shown moves the metal sheets to storage; from there another operator, with similar equipment, moves them to the shearers.



Application of variable speed transmission, roller chain, and friction brake to sheet-cutting machine attached to corrugating machine. National Box and Specialty Company, Sheboygan, Wis.



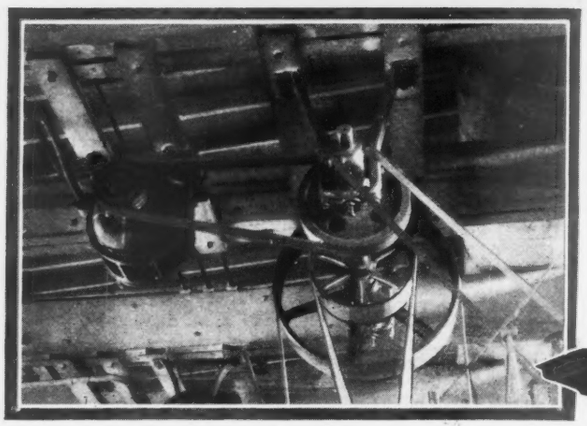
Courtesy Chicago Belting Company

The roll line in the plant of the Kansas City Flour Mills Company, Kansas City, Mo. The group method of driving is firmly entrenched.

MODERN EQUIPMENT AT WORK

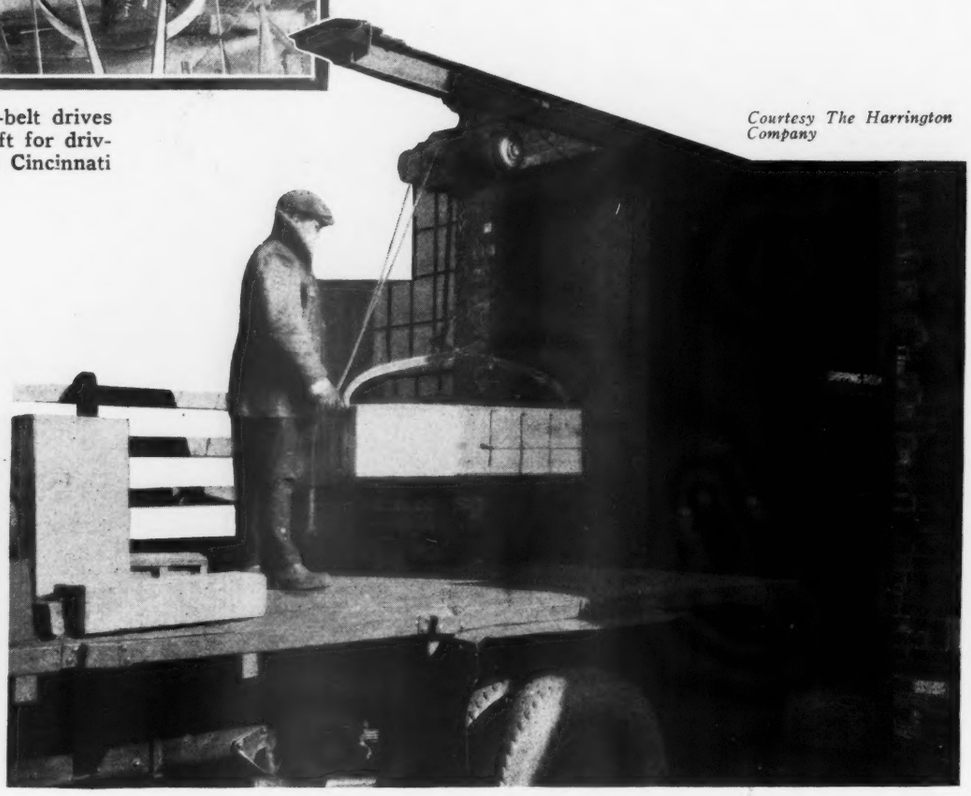
Courtesy Morse Chain Company

Air blown through the chain cools the bottoms of these newly molded bottles — plant of Obear-Nester Glass Company, East St. Louis, Ill. Falling of bottom, caving of sides of bottles is prevented. Production increase over old method, two bottles per minute.

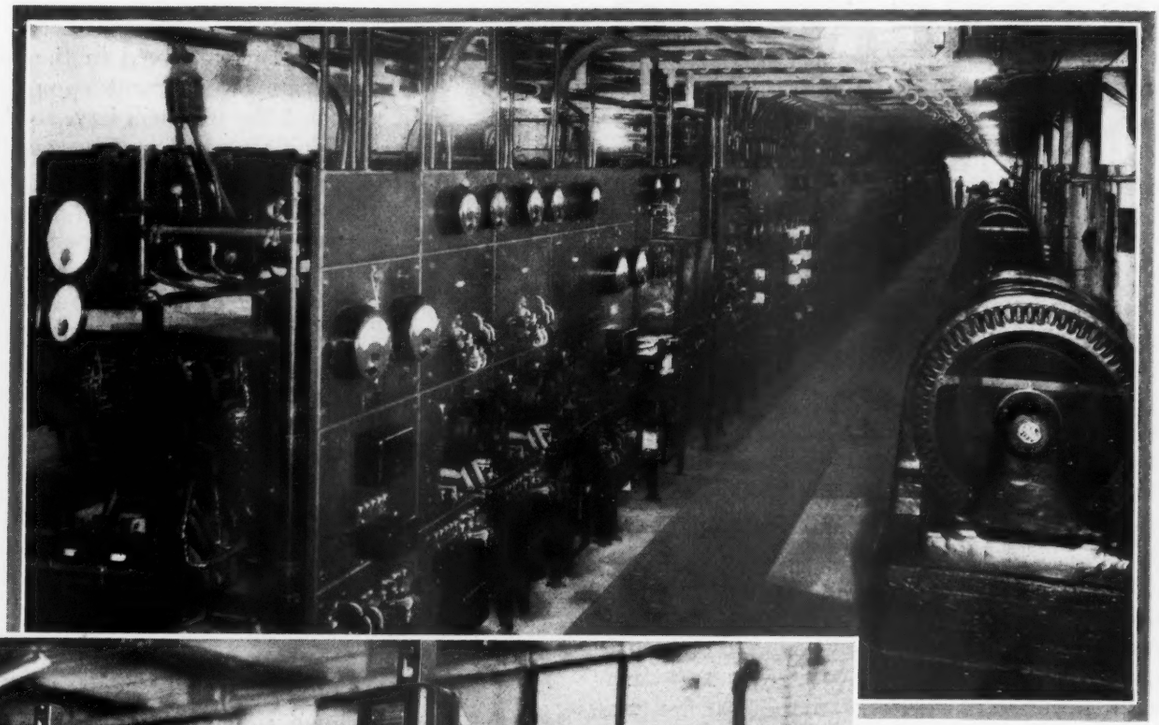


Motors and multiple V-belt drives replace the old line shaft for driving nine planers of the Cincinnati Shaper Company.

Courtesy The Harrington Company

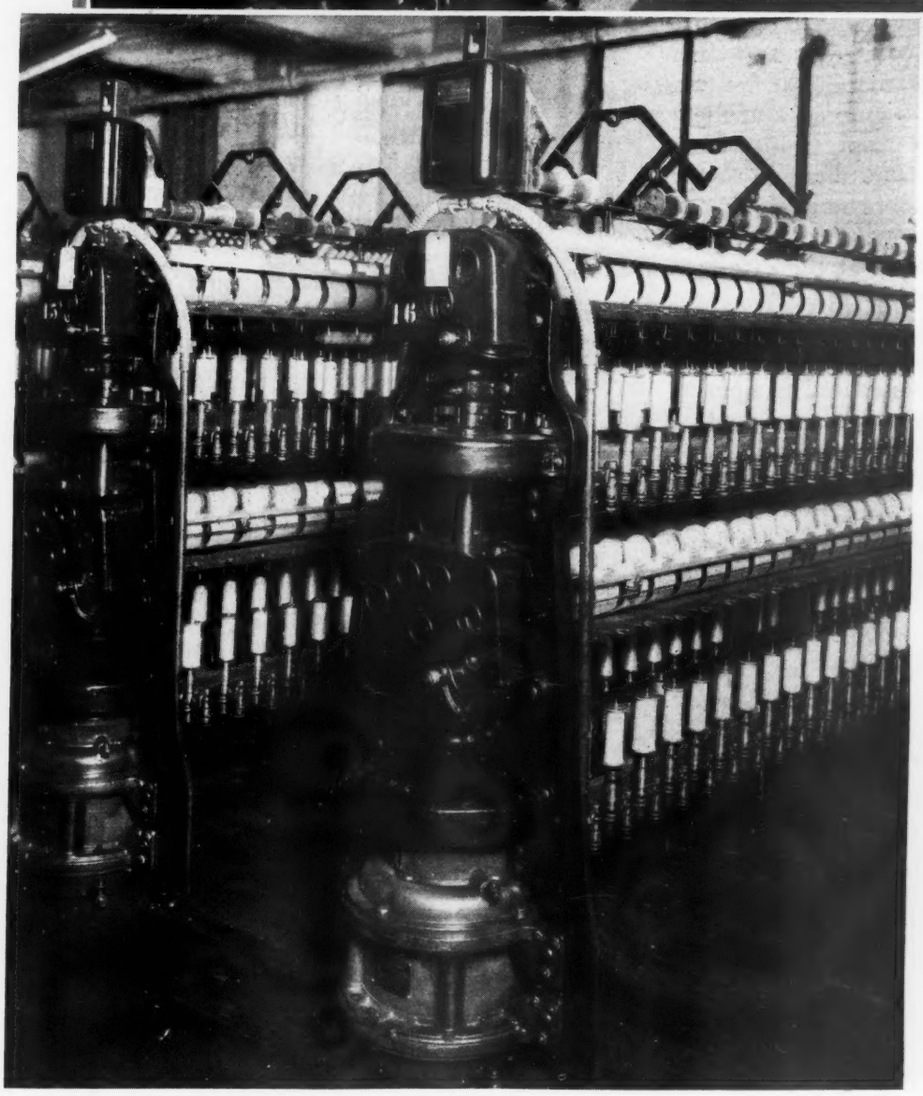


Every plant has loading and unloading to do. Here's how the Standard Stoker Company of Erie, Pa., uses a ½-ton electric hoist for part of its work.



Courtesy General Electric Company

Remote from the application of energy yet co-ordinating the drive elements of a paper machine. Synchronous and induction motor variable-speed control in the plant of the Ohio Boxboard Company, Rittman, Ohio.



Courtesy General Electric Company

As space savers in the Saquoit Silk Mill, Scranton, Pa., vertical drives find ready application. With push-button control overhead all moving elements of the spinner are under observation when starting.

INDUSTRIAL ENGINEERING

L. C. MORROW, *Editor*

Vol. 88 SEPTEMBER, 1930 No. 9

Fire-Prevention Week Is Near

"FIRE losses are in effect a tax on every man, woman, and child in the United States. This is one case where the 'taxpayers,' entirely by their own efforts, can reduce the rate. I hope we shall have no slackers in this campaign." The statement is that of President Hoover, made in reference to Fire Prevention Week, October 5 to 11.

Possibly the average individual will put forth his most earnest effort to prevent depletion of his pocketbook. How he can save money by never contributing to a fire is obvious. The rate of the insurance that he buys and that the manufacturers of every commodity he uses buy, is based on actual losses by fire; the nearer those losses approach zero the lower will be the rate, that is, the fire tax.

Is there room for much saving? Look at these figures: $464,706,102 actual property loss from fire during 1928; $473,574,019 estimated loss for 1929. Apparently there is opportunity for much reduction—if every 1929 loss had been prevented the savings would have piled up at the rate of a thousand dollars a minute.

So much for money loss alone. Consider, also, that the loss in lives is about 10,000 per year.

Fire Prevention Week is designated as a period during which educational activities designed to prevent fires are to be carried on. Each industrial plant should feel obligated to take part in these activities. If there is a scarcity of ideas or of educational material in any plant the deficiency may be remedied by application to the National Fire Protection Association, 60 Batterymarch St., Boston, Mass. This association is in existence for just such work.

Reinforcement for a Favorite Contention

UNEMPLOYMENT is the wolf that industry fights to keep away from its door. Employers work just as hard as employees that the wolf may not get the upper hand; they know that prosperity depends upon the buying power of the great employed group.

One of the latest forays against industry's wolf is being carried out behind a barrage laid down by the General Electric Company. It consists of "A Plan to Minimize the Cause and Effect of Unemployment" in all of this company's works. By the employees of some of the works the plan has been adopted, by others it is being considered.

There are many details involved in the plan, too many to enumerate or comment upon here. All appear to be sound, but trial will have to show how they wear. Significant among the provisions of the plan, so far as readers of *Industrial Engineering* are concerned, are these two:

"When business is increasing, postpone plant renewal and maintenance work as much as possible, employing the men on regular production."

"When work begins to fall off, use men on maintenance and repair work, bringing the plant and equipment up to a high standard. Proceed with construction of increased plant facilities previously planned, using our own men as far as possible."

Plant and equipment must be revised continually. Mighty sensible is any plant that assigns the big maintenance, rehabilitation, and expansion jobs to periods of slack production.

Permanency vs. Obsolescence

TO buy for long life or short? There is a question that you may like to play with. The design of industrial equipment has been advancing at a rapid pace. Much equipment otherwise quite serviceable has gone to the scrap pile because of obsolescence.

Equipment for the preservation of food furnishes a parallel to industrial equipment, and can be used as an example without bruising any toes. Many a good ice box has been relegated to the kitchen, the woodshed, or the barn, or traded in for a few dollars to make way for the automatic refrigerator. It turns out that a box at half the price paid would have been a better buy. The insulation would not have been so good, or the wood so well seasoned; the hardware might have rusted. But even so the buyer would be in pocket.

In industry it's a question of whether to buy equipment that will run on and on, with little necessity for maintenance, or to buy something maybe half so good, give it plenty of work, and patch it up occasionally, all upon the basis that it will be obsolete after a few years of service.

It happens, though, that long life and quality go hand in hand as a rule. It is possible that one cannot help buying long life in equipment if he gets something that is made right. If that is so he may be forced to adopt the policy of working the equipment right up to the limit of its capacity in order to get all the service paid for before obsolescence has arrived.

There is still another consideration, which is that the long-lived equipment may be the cheapest

in the long run, even though it is not half worn out when scrapped. Perhaps its quality will have prevented expensive shut-downs that would have eaten up the savings on a half-dozen units of equipment of its kind.

No stand one way or the other is taken here. It happens that the policies of buying for permanency or in expectation of obsolescence are being weighed right now by manufacturers and users of equipment. The ground on both sides of the fence should be examined carefully before a jump is made and there is no angry bull in the immediate vicinity to force a choice. The question is presented so that inspection of landing places may be at least begun before the bull appears, assuming that he will.

Architects and Illuminating Engineers Break Bread Together

WITH the rapidly-increasing development of, and specialization in, the various branches of engineering there is increased need, but greater difficulty, for the members of one branch to keep informed on what the others are doing. How this interchange of information and ideas can be handled best may be open to argument. However, a forward step that is unique in its conception has been taken by the Illuminating Engineering Society through the organization for its members of a course of lectures on the fundamentals of architecture.

To meet the convenience of the members two schools were conducted concurrently during the week of September 8. The Eastern school was conducted at the headquarters of the Architectural League of New York, in New York City, under the auspices of Columbia University. The Middle Western school was held at the Art Institute in Chicago by the schools of architecture of the University of Illinois and Armour Institute. Registration was limited to 75 in the Eastern school and to 100 in the other. In both cases a fee of $25 was charged for the course, which consisted of lectures and inspection trips.

The architect and the illuminating engineer have many interests in common, and the I.E.S. is to be congratulated on its purposeful endeavor to acquaint its members with the problems, viewpoints, and ideals of this other great group. The result of this study of the other fellow's work hardly can fail to be inspiring and helpful, and lead to closer co-operation.

Perhaps this example will stimulate thinking on the part of the other engineering societies and organizations as to the most effective means of bringing to other related groups of engineers that intimate knowledge of our fellow worker's problems and aspirations which we all need.

Advocating the Stitch in Time

BY this time *Industrial Engineering* must have established among its readers the feeling that modernization is just about the most necessary virtue for industrial plants to possess. Last October there was a modernization issue. In February of this year we said, "Prepare Now for Cheaper Production," and told in detail what to do. In July we showed actual modernization activities in another modernization issue. The August issue continued the presentation of pictures of modern equipment at work, and so does this (the September) issue. Yes, we're serious when we advocate modernization.

Frankly, last February we didn't think there was going to be such a long pull to get out of the depression. Now we feel that the end is approaching, but that there is still time for modernization work to be gotten well under way by those plants that have held off. One of the members of our organization has been checking the attitude of bankers toward such programs, and he finds them favoring it heartily. The fundamental reasons why the policy is sound are:

1. That a manufacturer can get more for his modernization dollar now than at any time since 1921.

2. That by present modernization he will be ready with cheaper production costs for competition that he will find when buying again becomes active.

There are certain supporting reasons, among them:

(a) Plants are operating now at only fair capacity, so that modernization at this time will not interfere with production.

(b) Many materials and items of equipment are cheaper now than for several years.

(c) Labor efficiency, both in the factory and in construction, is higher than at any time since 1921, and in some cases is higher than at any time since 1913.

(d) Many companies piled up surpluses in recent prosperous times and have cash available for modernization.

(e) The big corporations, which must plan capacities far ahead, are modernizing or expanding plants during this period.

Possibly we are biased, but we can't help believing that it's common sense for the man who really believes in the future of his own business to prepare now to handle the orders when they come —as they will.

Coming next month—Another of the Articles on Organization for Plant Engineering

Meter Records Polyphase Power Factor

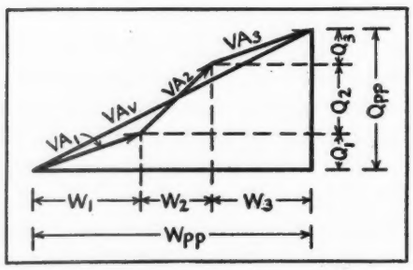
MEASUREMENT of true polyphase power factor is now possible because of the development of a recording polyphase power factor meter that indicates and records polyphase power factor according to the definition adopted recently by the A.I.E.E. as standard. The simple definition of power factor as the ratio of watts to volt-amperes has long been recognized as being adequate only for single-phase circuits, while in the case of polyphase circuits power phase unbalance altered conditions so that the indications of the usual power-factor meter were meaningless.

Under the present adopted definition—"ratio of total watts to the vector sum of the volt-amperes in the several phases"—this vector power factor may be quite different from that of any individual phase as may be seen by referring to the power vector diagram in the accompanying illustration.

This instrument functions on the relay principle in that a Kelvin balance operates a set of contacts in the circuit of the control motor driving the worm-geared pen. If the torque on this balanced wattmeter element is positive the pen will move up scale, and vice versa. A phase shifter is mechanically connected to the recording mechanism by means of a worm wheel in the gear drive, the ratio of which is such that when the pen is driven the length of the scale the phase shifter produces a corresponding shift of 120 electrical degrees between the current and the voltage. The primary winding of the phase shifter is connected to the line voltage and the secondary winding is connected to the moving coils or potential circuit of the wattmeter element.

A brief discussion of the operating principle of this meter follows: If a Kelvin balance element is arranged as a wattmeter, by connecting the stationary coils in series with the line and the moving coils across the line, the torque will be proportional to the power in the circuit. If the current in the potential coils is shifted by means of a phase shifter so that it lags line voltage by 90 deg. the torque of the balance element will then be proportional to the reactive volt-amperes in the circuit. With this condition the torque of the element would of necessity be zero when the power factor of the line was unity. For any other value of line power factor the element would have a torque proportional to the variation of the power factor from unity. If the quadrature current in the voltage coils is obtained by means of a phase shifter, the angle through which the phase shifter must be rotated to give rise to the condition of zero torque in the element is the same as the vectorial mean angle of lag or lead.

Therefore, for any power factor of the line, the circuits of the balanced element are brought to a condition resulting in zero torque. Any change in line power factor will produce a torque on the meter element, causing the control motor and phase shifter to readjust the system mechanically and electrically to the new power factor. The co-ordination of the system of Kelvin balance, control motor, and phase shifter keeping the torque of the element zero causes the pen to assume a position on the scale corresponding to the vertical mean angle of lag or lead. The cosine of this angle is the vectorial power factor as recognized and defined by the A.I.E.E., so the scale is marked accordingly.



Vector sum versus numerical sum of polyphase volt-amperes. The total active power of three-phase unbalanced circuit is represented by Wpp, which is equal to the sum of the power in the individual phases ($W_1 + W_2 + W_3$). Similarly, the total reactive power Qpp is equal to the sum of the reactive power in the individual phases ($Q_1 + Q_2 + Q_3$). It is obvious that the sum of the volt-amperes in the three individual phases ($VA_1 + VA_2 + VA_3$) is not the same as the resultant sum VA_v. If individual single-phase power factor meters were used they would measure:

$$\frac{W_1}{VA_1}, \frac{W_2}{VA_2} \text{ and } \frac{W_3}{VA_3}.$$

Electro-Deposition Process Widens Use of Rubber

BY reason of the commercial development of the electro-deposition process rubber takes on additional importance as a material for an increasing variety of industrial uses. Of the several methods of applying rubber to iron, steel, and other metals, this process is perhaps the most satisfactory.

Use of these processes makes it possible to coat acid tanks, for example, with a soft rubber lining; to coat metal plates with a rubber covering to resist abrasion, and to use rubber in numerous other ways where its corrosive- and abrasive-resistance properties are desirable.

Under proper conditions rubber possesses great resistance to corrosion and abrasion. This property has caused it to be extensively used in the chemical industry for containers and equipment handling acids and corrosive solutions; as linings for ball mills in cement plants and chemical plants; as surface material on chutes carrying abrasive materials; as coverings for fan blades in exhausters where corrosive gases are encountered; as plates in filter presses; as protective coverings on dredge shovels.

Another recent use of rubber is for "cutless" bearings, lubricated with water, in centrifugal pumps handling abrasives in solution.

Save Your Tips

WELDING heads cost money, and yet very often they are allowed to lie around loose on welding tables or benches, getting knocked about and covered with dirt, making good work difficult, if not impossible.

Provide a suitable place for keeping them clean and in good condition. A small wall rack or a box attached to the welding truck will do the trick.

RUBBER PAVEMENTS in industrial plants?

Here are some highway results

By HARRY W. NEWMAN
Rubber Division
Department of Commerce

MUCH interest has been stimulated recently among highway engineers and rubber technicians relative to the place rubber will hold in the construction of sidewalks and city streets. Only since the World War have engineers given the matter serious thought, although experiments in the employment of rubber for roadways go back to the year 1870. It is claimed by some authorities that rubber pavements have not been perfected to satisfy all interested parties, but that there is a wide field of usefulness for such a product is readily conceded by rubber engineers.

Highway experts generally acknowledge that the ideal material for modern road construction has yet to be discovered. Wood blocks, compressed asphalt, concrete cement, heaped asphalt concrete, circular bituminous concrete, and other materials have been used, but in almost every instance the all-around composition for paving is unknown.

Rubber has indeed many of the properties of other raw materials and, in addition, many qualities not found in any other substance, for instance, shock absorption, elimination of noise, resistance to wear and tear, and cleanliness. Furthermore, rubber does not create any dust, and therefore is claimed to be the outstanding hygienic material for paving.

The United Kingdom has been the pioneer in the production and use of rubber paving blocks and at present five types of blocks have passed beyond the experimental stage and have been employed in that country, upon the Continent, and in Asia. The United States has, so far as is known, devised three types of paving blocks, all of which have been used upon this side.

The North British product, manufactured in Scotland, has been used at both Glasgow and Edinburgh. The other four types have been employed at London. At Singapore the Cresson was used, whereas the Gaisman has been used, besides in London, at both Manchester and Paris.

The Cowper is more of the slab type. It is composed of three layers of hard rubber of different grades, the softest one being near the surface.

The foundation of the Leyland type is a composition of hard material upon which is vulcanized a surface of rather soft rubber.

The North British consists of two bases of rubber of one inch thickness each, of different degrees of hardness. The yielding or softer grade is at the top, and the semi-hard below. The latter is attached solidly by metallic hooks and slabs to a concrete base.

The Cresson is a type of more complex construction, with surface consisting of a layer of supple mixture, and having two intermediate layers and a base. The second and third layers are of increasing hardness, whereas the base is of a special composition formed of rubber, gravel, sulphur, and other materials.

Dimensions of the five blocks of British origin are given in the accompanying table.

DIMENSIONS OF BLOCKS OF BRITISH ORIGIN IN INCHES

Type of Block	Length	Width	Hgt.	Thickness of Surface Rubber
Cresson	9	3	3⅔	⅔
Gaisman	10⅓	8½	4½	½
Leyland	8	4	3	½ and 2⅓ of hard base
Cowper	13⅓	9	2¼	⅔
North British	9	8½	4	1 of hard base

The Gaisman appears to be a composite type of the other four. Its original quality, however, is found in the manner in which the rubber is joined to the base. Furthermore, the base is of vitrified brick, specially baked at high temperature and made of select materials. The rubber is made of two layers, one being soft and the other hard. The blocks grip one another with hooks and mortises in dovetail fashion.

Each of the different paving systems has its own characteristic way of construction. Gaisman and Cresson are laid on a foundation of concrete with an intermediate bed of sand. Each block, before being laid, is dipped in a special warm binder, the "Rubgrip" for the Gaisman and the "Invicta" for the Cresson. Cowper slabs are laid close together on a foundation of concrete, but without any binder whatsoever. Leyland

IN FAVOR
- **Shock absorption**
- **Elimination of noise**
- **Resistance to wear**
- **Cleanliness**

FOR FIRST CONSIDERATION
- **Aisles**
- **Walks**
- **Floors of offices**
- **Hospitals**
- **Dining Rooms**

blocks are laid directly on a concrete foundation after having been dipped in a warm asphalt composition. As for the North British, they are laid on concrete, the joints being cemented with a hot, bituminous binder.

The Gaisman paving block, which has, perhaps, been used more than the others, is in the form of a rather large block, weighing about 28 lb. The block, before it is baked, is molded under pressure and is thus prepared to absorb a mixture of the hardening material which insures cohesion between the base and the top surface. The small hollow spaces, one of the patented features of the block, have been given considerable study and it is claimed that their effective energy is unquestionable. Corrugated surface prevents sliding and skidding, and has been tested with both pneumatic and solid tires.

The Wright Rubber Products Company of Racine, Wis., possesses a patent on rubber paving blocks that have been used in both Boston and Chicago. The blocks laid in Boston were 6 x 12 in. and of one inch in thickness. They were compounded of about one-third fresh rubber and two-thirds reclaimed and, in vulcanizing, the blocks were subjected to 333 deg. of heat and 2,500 lb. pressure. They were constructed with two semi-circular flaps on one side and another flap on one end of the base of the block, which fit into corresponding recesses in the base of the adjoining block. Blocks are laid one plain and the next corrugated in hot rubberized cement.

Experiments with rubber paving blocks have for some time been carried on by the Goodyear Tire & Rubber Company, of Akron, Ohio. In the latter part of 1923 the company laid a stretch of street pavement in front of its own offices with blocks from the Akron plant. The blocks were about the same size as the common paving blocks, but the ends were grooved and when laid were first dipped into a hot tar compound to form water-tight joints.

The third company which has experimented in the manufacture of rubber paving block is the Boston Woven Hose & Rubber Company, of Boston, Massachusetts.

The Electro-Cable Company, a large French manufacturer of rubber flooring, has performed many experiments with rubber paving blocks in its laboratories and has given thought to all possible forms of paving and ideas relating to them. After careful consideration the company finally reduced its models to two types—the slab and the block systems. This company bought the Gaisman patent rights and immediately received permission from the Labor Office of Paris to demonstrate the efficacy of the Gaisman paving. The first experiment in Paris was made in March, 1929, and from all reports it has proved successful.

The Plant on the Cover

AN airplane view of a printing plant decorates our cover this month. The plant is that of the Condé Nast Press, Greenwich, Connecticut. The buildings occupy five of the 40 acres of ground which are plant property. Fifteen acres have been landscaped, 20 remain undeveloped. A large staff is engaged in the maintenance of grounds; it is under the direction of a landscape engineer and architect retained the year round.

The large building in the background does not belong to the plant. In the center of the group of buildings is the multi-storied administration wing. Adjacent to this wing (immediate background) is the Condé Nast Press building and in the foreground is the pattern building in which Vogue patterns are made. Back of the Press building are the automobile sheds for employees. There is no charge for storage and it is an incentive for employees to arrive on time in order to obtain individual car space; first come, first choice.

All manufacturing is done on one floor. There is a second-floor paper-stock room, and additional storage space is provided in a basement. The slope of the ground permits splendid natural light in the basement and the maintenance department is housed there.

Seven hundred people are employed in the Press division and 400 in the Administration and Pattern divisions. Of the total, 20 employees are engaged in maintenance; they include machinists, electricians, plumber, carpenters, and painters. The man in charge is referred to as the chief of the maintenance department. He works very closely with all department heads and reports to the assistant general manager. In referring to its maintenance work one of the members of the organization said: "I believe that we have a larger maintenance force for our size of plant than most organizations, due to our policy of maintaining machines properly rather than waiting for a breakdown to disclose the need for repairs. We have always considered this good insurance."

In addition to the plant maintenance department there is a small machine shop and garage for the maintenance of the company's seven 6-ton trucks. A mechanic and a helper are in attendance and the garage is adjacent to the 8-car garage where the trucks are stored.

There are 300 motors ranging in size from ⅛ hp. to 25 hp. Total connected horsepower is approximately 1,000. Within the machine shop there is a motor service department by which all motors are regularly maintained.

The plant is equipped with a humidifier system; belonging to it are 63 units distributed throughout the press room and paper-stock room. A heat regulator system maintains a uniform temperature.

Press room and composing room are equipped with glassteel diffuser units. Special globes, designed that colors may show their true values, are installed over the presses in the color press room. The total number of lamps is 2,500.

A special flooring was installed during the past year in the bindery and press room. It is a wood-block flooring made of southern pine with the tough end grain up. The blocks are dovetailed endwise to baseboards of 8-ft. length.

Walls and floors are vacuum cleaned. Dust interferes greatly with good printing and cleaning by broom or other dust-raising medium could not be tolerated.

Heat requirements are taken care of by two 360-hp., upright boilers for winter service and one 7-hp. boiler for supplying hot water and for counteracting the chill on cool summer days.

Steel-Plate Floor Assembled by Welding

AN automatic arc-welding machine, under its own motive power, has demonstrated its value in the construction of a new type of steel floor for buildings. The machine was developed by the General Electric Company, in Pittsfield, Mass., and a garage was the first to use it on what is known as the "battledeck type of floor construction."

As used in this building, the battledeck floor consists of 5-in., 10-lb. I-beams, spaced 24 in. on centers with ¼-in. steel plates placed from the center line of one I-beam to the center line of the adjoining I-beam and from center to center of girders. An allowance of ¼ in. between plates was made. The battledeck construction weighs 15 lb. per sq. ft. as contrasted with 75 lb. for concrete slab construction.

The fabricators procured plates stretched and squared with a limitation of $\frac{1}{16}$ in. plus or minus. The plates arrived on the premises by truck and were independently hoisted to the second floor and laid in place. The resulting platform was used by the other building trades for the construction of the walls, placing the roof on the trusses, and so forth. It was found that no movement of the plates took place at any time.

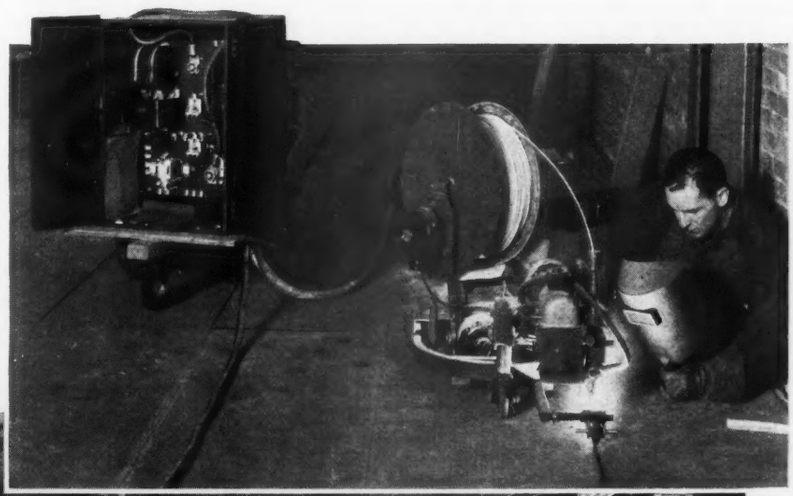
There was used a total of 193 separate plates each 2 ft. wide x 20 ft. long, making a total area of 40x160 ft. or 6,400 square feet.

Although the battledeck floor can be covered with any material such as cement, rubber tile, linoleum, or cork, it was unnecessary in the Pittsfield garage as the steel floor provided enough friction to prevent skidding.

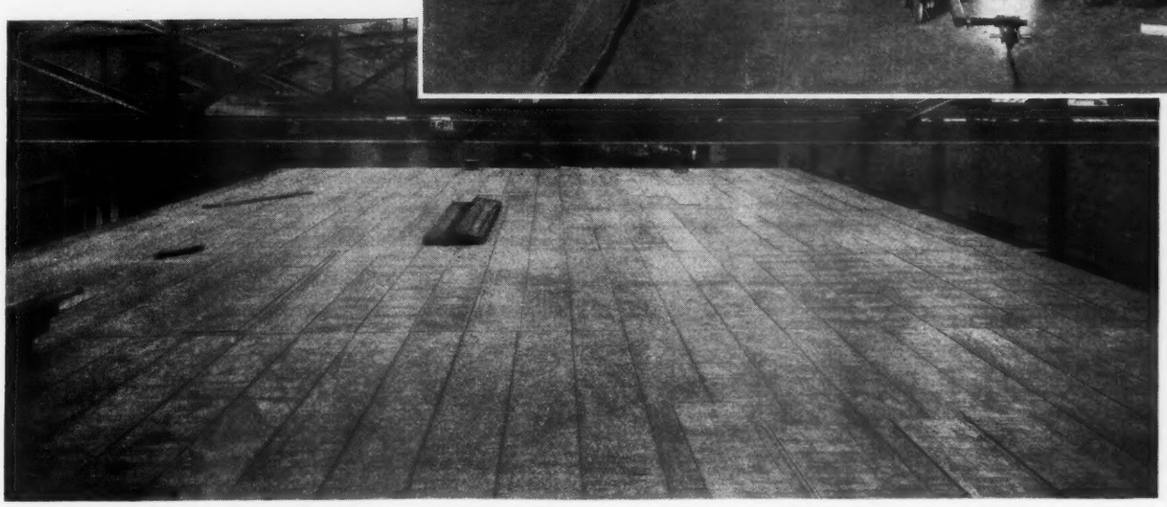
The automatic arc-welding machine used is a three-wheeled, self-propelled vehicle driven by an adjustable-speed motor. On the framework are mounted a welding wire feeding device, a reel of welding wire, the travel motor and the control device. A gas-engine generator installed on a truck on the ground below supplied, through a trailing cable, the current for welding and for operating the travel motor. An auxiliary control panel is used at the point of welding.

The machine, once started on a seam, was almost entirely automatic in operation, following the seam and feeding the electrode. About 30 min. were required to weld 20 ft. of the ¼-in. seam using a 5/32-in. electrode.

Various types of welds are possible, but the one used at Pittsfield was a flush weld presenting a smooth surface all the way across the entire floor. The welds not only join the steel plates but also weld them permanently to the I-beam below.



The automatic arc-welding machine at work joining the steel floor plates into a solid mass.



Steel floor plates in place on the girders ready for the welding machine.

Operating Costs and Performance Records of a 40-Ton Industrial Electric Locomotive

By E. B. EDWARDS

Industrial Department
General Electric Company
Erie, Pa.

INDUSTRIAL haulage covers a wide field of application. It is the purpose here to say something about handling standard railway cars. Where there is a railroad connection, the tracks about the yard are laid to standard gage. This simplifies the distribution of incoming and outgoing freight that is handled in carload lots. With such a layout, a switching locomotive is an essential part of the plant equipment.

Along with the rapidly increasing use of electricity in the industries it has been shown that the electric locomotive can be used to advantage in general yard haulage. The electric locomotive has distinctly favorable characteristics for yard shifting work. For example, the control is simple, all of the equipment is easily accessible, thereby simplifying repairs, acceleration is smooth, and no power is consumed while idle. These features combined with the freedom from smoke or obnoxious gases and the elimination of noise are highly in favor of the electric locomotive.

Industrial haulage problems, particularly those that relate to the type of locomotive to be used, cannot be covered by general recommendations. The work to be performed at one factory combined with its particular yard track layout may call for a trolley or third rail locomotive, whereas another plant can be served by some other form of locomotive, such as the storage battery type.

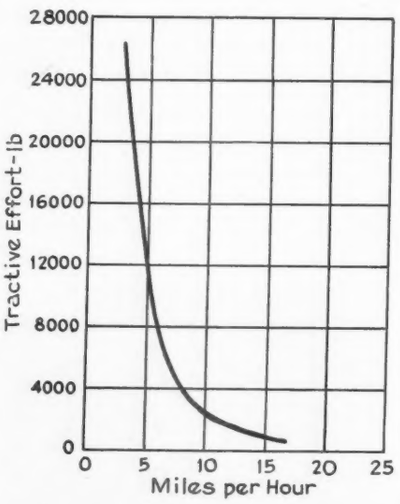


Fig. 2—Tractive effort-speed curve of a 40-ton locomotive equipped with a storage battery consisting of 100 13-plate cells.

The storage battery locomotive is now available in larger sizes, since suitable, large-capacity batteries have been developed for this kind of duty. In the larger sizes, 30-, 40-, 60-, and 75-ton units have been built and placed in successful service, and it is not unreasonable to expect to see even larger sizes within a short time.

From investigations that have been made in this field of application, a large amount of useful data has been obtained. Data on a 40-ton storage-battery locomotive of the type shown in Fig. 1, are included. The tractive effort-speed curve of this locomotive is shown in Fig. 2.

For a period of several days a complete log was taken of all movements, distances and loads moved. From these service logs average figures given in Table I were obtained.

In the yard in which this test was made, the tracks are level and well laid and, where a similar installation is considered under like conditions, comparable results could be expected. If loads have to be handled against grades or if other adverse conditions enter into the problem, these factors must be taken into consideration in the selection of the locomotive weight required and the battery capacity needed to perform the intended service.

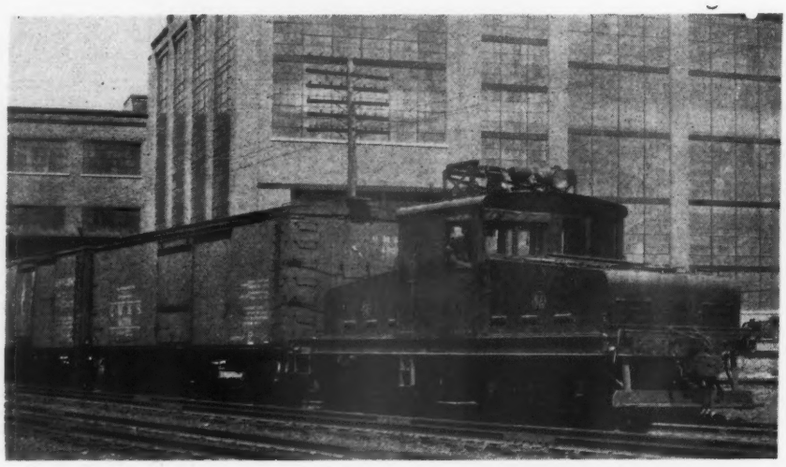


Fig. 1—This is a 40-ton storage battery switching locomotive designed for yard switching service in industrial plants.

From figures

available from actual cost records, the cost of operating such a 40-ton storage battery locomotive has been compiled and is given in Table II.

In industrial haulage service the life of a lead-acid battery based on one cycle of discharge per day is usually from three to five years. The data given in Table II are based on a three-year life, which is probably conservative. The company that owns a locomotive of this type should set aside yearly an amount to cover battery renewal so that, at the end of three or more years, it will not be necessary to write off at one time the entire cost of a new battery.

This class of service calls for locomotives of slow-speed characteristics and of strong construction suitable for heavy intermittent duty. The discharge characteristics of the storage battery are particularly suited for this. The battery is charged at night under favorable conditions at a very low cost. On the whole, the storage battery locomotive is well adapted to the short heavy hauls required in yard shifting service for manufacturing plants, steel mills, central stations, quarries, open pit mining, and the like. Where hauls are long and 24-hr. service is required some other type of electric locomotive can be found to satisfy these requirements.

TABLE I—AVERAGE DAILY PERFORMANCE OF 40-TON STORAGE-BATTERY LOCOMOTIVE

Length of test	8 hr.
Time locomotive was in motion	4 hr. 19 min.
Time idle and lost in coupling	3 hr. 41 min.
Percentage of time idle and lost in coupling	43.4
No. shifts per day—total	101
No. shifts light	28
Ave. length of shift	1,162 ft.
Ave. weight of trailing load	104 tons
Ave. speed with trailing load	4.72 m.p.h.
Max. trailing load during test	810 tons
Total distance covered	22.88 miles
Distance covered light	7.05 miles
Total ton-miles (locomotive included)	2,757
Kilowatt-hour consumption	164.9
Kilowatt-hour capacity of battery	211

TABLE II—COST OF OPERATING 40-TON STORAGE-BATTERY LOCOMOTIVE

Locomotive complete	$30,000
Battery, 100 cells FL-13, inc. at	11,960
Cost of battery renewal, approx.	10,000
Interest, taxes and insurance at 8%	2,400
Depreciation locomotive, 5%	902
Depreciation of battery (3 yr. life)	3,333
Maintenance and repairs	1,500
Charging power 2c. per kw-hr.	1,800
Distilled water at 5c. per gal.	30
Motorman's wage $5 per day	1,500
Total cost per year—300 working days	11,465
Total cost per day (8 hr.)	$38.20

BOOKS

The Fundamental Theory of Electrical Engineering

By Arthur Lemuel Albert, Assistant Professor of Electrical Engineering, Oregon State College. Published by Ginn and Company, 15 Ashburton Place, Boston, Mass. Cloth, 313 pages, illustrated. Price $3.20.

SO many and varied are the present applications of electrical energy that there has been need of a detailed treatment of the fundamentals on which electrical engineering is based, without undue emphasis on their application to any particular branch. The present volume represents an attempt to fill that need. Designed primarily for use in college courses by electrical engineering students, the subject matter and its manner of presentation will be found interesting and instructive by other groups who desire training in fundamental theory, including engineers who wish to bring themselves up-to-date.

The scope of the work is indicated by the following chapter headings: Elementary Principles of Mechanics; Theories of Electricity; Units of Electrical Measurement; Conductivity in Solids; Electrochemistry; Conduction of Electricity Through Gases; Direct-Current Circuits; Electrical Power and Energy; The Dielectric Circuit; The Magnetic Circuit; Inductance; Alternating-Current Theory; Solution of Alternating-Current Problems; Polyphase Alternating-Current Circuits; Electrical Measuring Instruments.

Structural Aluminum Handbook

Published by the Aluminum Company of America, Pittsburgh, Pa. Size, 5½x8½ in., cloth, 106 pages.

AN engineering reference book intended to provide for the designer and builder the information needed for using aluminum structurally.

Treated are the manufacture of aluminum alloys; mechanical properties of aluminum alloys; design of aluminum alloy structures; structural use of various alloys; construction practice for aluminum alloys; finishing aluminum surfaces for protection or decoration.

Tables giving the elements of sections of structural shapes fill 44 pages. There are, also, technical data on miscellaneous structural products, conversion tables, and other useful data.

The handbook is published appropriately at this time because of the advent of aluminum and its alloys into the field of "strength" structures.

Mathematics for Electricians

By Martin H. Kuehn, Instructor of Mathematics, Seneca Vocational High School, Buffalo, N. Y. Published by McGraw-Hill Book Company, 370 Seventh Ave., New York, N. Y. Cloth, 216 pages, illustrated. Price $1.75.

ALTHOUGH this book has been designed primarily for use in vocational and similar schools, it should be of material aid to workers who are unable to attend school, but wish to learn more about the mathematics of their trade. The numerous illustrative examples for which the solutions are given should enable one of any training to master the mathematics required in the solution of ordinary, practical electrical problems. Particular attention has been paid to mathematical principles in the sample solutions.

Electricians whose practical experience exceeds their mathematical training will find this little volume useful in remedying that deficiency.

AROUND *the* WORKS

THIS SECTION is especially devoted to short articles describing ideas and practical methods devised to meet particular operating conditions. The items may refer to mechanical details of installation, inspection, testing, wiring, repair, maintenance, replacement, and emergency or unusual installations of equipment tributary to production. Special attention is given to shop or bench tools and short cuts or improved methods of handling work brought into the repair shop. Contributions from our readers are always welcome.

Blower System Has Dual Uses—Material Handling and Ventilation

WHEN making a fair-sized blower installation, it is quite often possible to utilize all or a portion of the blower intake for general ventilating purposes.

On an air-conveying job in a certain plant there were two different blowers required; one a slow-speed exhauster of large size for short lifts, the other a high-speed blower.

Both blowers were located near a large central office in which ventilation was inadequate because of the number of small cubicles it contained. The intakes of the blowers were piped to the walls of this central office and properly expanded to pierced grills. To cut down noise, it was found necessary to install a canvas joint in the intake of the high-speed blower. This idea has saved the expense that would have been necessary for a separate ventilating system.

Toronto, Ont., Canada JOHN RELYEA.

Proper Lubricant Corrects Bearing Trouble

ON several occasions the bearing between a motor and a turbo-blower burned out. This unit is very important in the process for which it is used and owing to the construction it was necessary to remove the motor, pull the flexible coupling, and jack up the turbo shaft to remove the bearing shells. With a spare set of bearings a half day was required to complete the job.

At first the oiler was taken to task for neglecting this bearing, but an inspection disclosed the fact that this bearing required considerable oil to maintain the required level. On this type of fan the air is drawn in parallel to the shaft, which action tended to pull the oil out of the bearing despite the fact that leather gaskets had been provided by the maker to prevent this action.

Although a good grade of lubricant was used on this bearing it was found at times that the oil would be sucked out from one day to the next. Frequent replacement of gaskets did not seem to give any appreciable relief. While in conversation with a lubricating engineer of the manufacturer from whom our lubricants are purchased this trouble was mentioned. As a result a grade of lubricant which resembles molasses in consistency and, therefore, able to resist the sucking or capillary action was recommended. Since using this grade of oil it has only been necessary to renew the oil at regular intervals. This experience proves that it pays the maintenance man to tell his troubles to the other fellow.

R. F. D. 3 H. E. REINHOLD.
New Philadelphia, Ohio

Arc Welding Adds Life to Large Crank Shafts

OFTENTIMES, the repair or replacement of work crank shafts of large engines has been the cause of much anxiety among men who are responsible for the operation of these units. A large pump or compressor is seldom shut down for an indefinite period to allow time for manufacturing a new crank shaft if the bearing surface only is in need of repair, that is, to be built up and machined to the original diameter.

By means of the arc-welding process it is possible to build up large shafts that are worn and thereby save money for a company whose equipment includes these large engines. After welding they can then be turned down again to the proper diameter. In many cases thousands of dollars have been saved on single shafts repaired and returned to service with the aid of the arc-welding equipment.

The crank shaft shown in Fig. 1 is being repaired in this manner. This shaft was in use in an ammonia compressor. It measures 12 in. in diameter, and weighs 14,000 lb. The cost of a new shaft would be approximately $8,000, but the old shaft was repaired and replaced in the compressor at a cost of $800.

In repairing this shaft it was necessary to build up the main crank bearing and the flywheel fit. The main crank bearing was built up approximately one

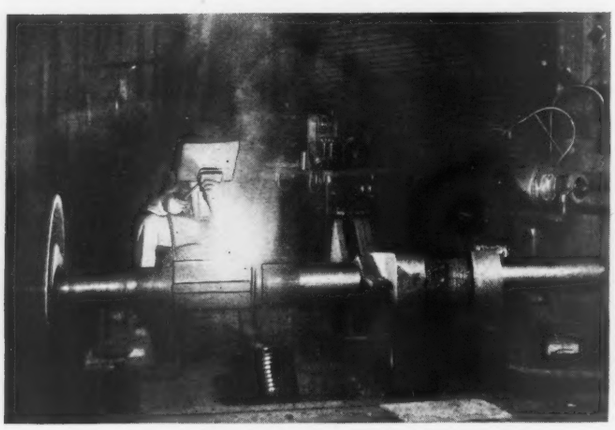


Fig. 1—Showing an operator building up a large crank shaft. The bearing on the right has been built up and is ready for machining.

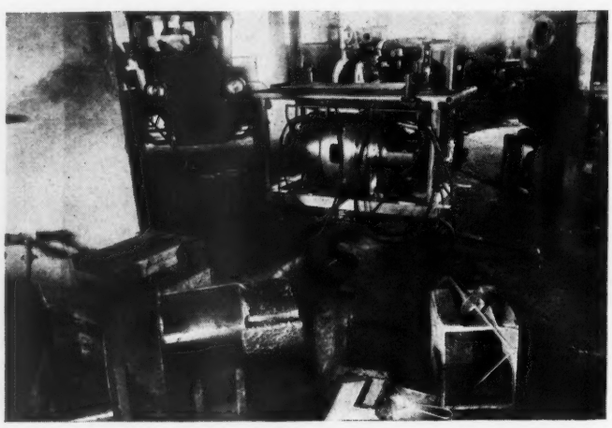


Fig. 2—This shaft was taken from a three-cylinder Diesel engine. It was repaired by arc welding when a piece cracked off as shown.

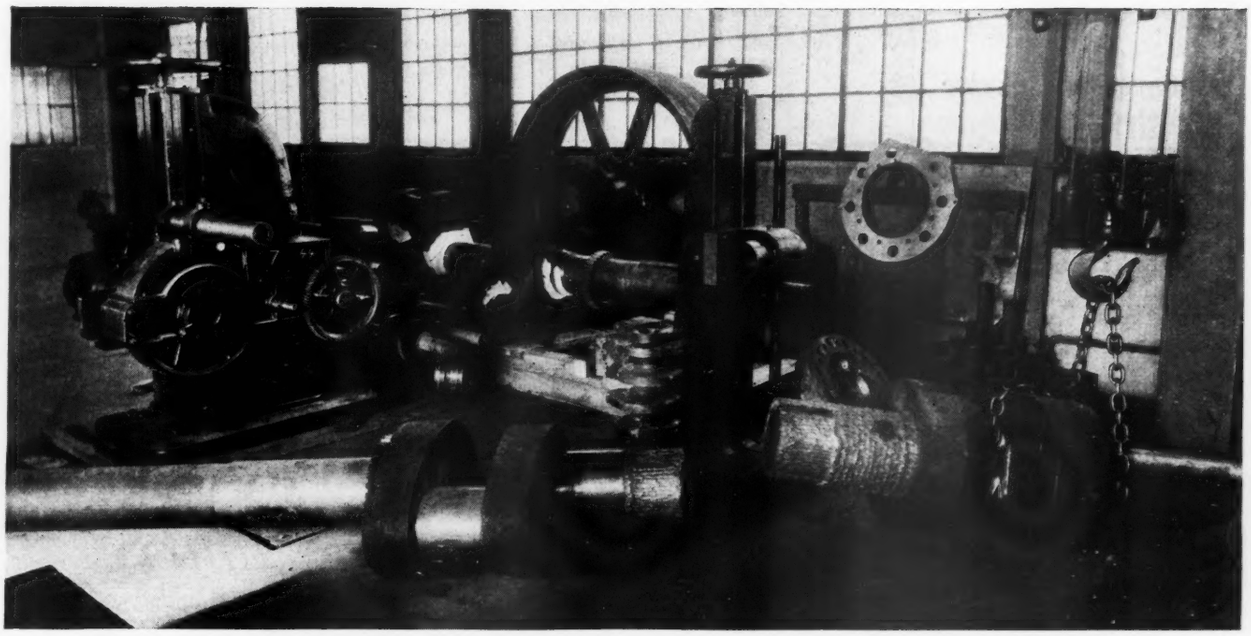


Fig. 3—A considerable saving was effected in repairing one of these shafts. Note the method of locating invisible cracks on the shaft in the background.

inch by depositing nearly 150 lb. of weld metal on the shaft; it was then turned down to the proper size. The flywheel fit was built up approximately ½ in., then bored to fit the shaft. Half-inch electrodes were used with a current of 650 amp. in building up the surfaces.

In Fig. 2, a three-cylinder, Diesel-engine crank shaft, with a piece cracked off the main bearing, is shown. This shaft is 10 in. in diameter and weighs 7,000 lb. When new it cost $3,000, but it was repaired and returned to service at a cost of $770. In repairing this shaft, ½-in. welding electrodes and a current of 600 amp. were used. After being built up it was machined to fit the crank bore.

Two 12-in. Diesel-engine crank shafts, each weighing 14,000 lb., which came loose in fit, are shown in the foreground in Fig. 3 immediately above. These shafts were in use in pipe-line pumping stations. The cost to replace them would be approximately $14,000 each, but by the use of arc welding it was possible to build up the shaft, machine them, and restore them to service for $900 each.

In the foregoing instance the shafts were trucked nearly a thousand miles to the shop in which they were repaired.

They were returned to service in a period of six days.

In the background of Fig. 3 another interesting point is illustrated in the repair of large crank shafts; that is, the method of locating cracks in the metal, which are invisible to the naked eye. This is done by thoroughly cleansing the crank shaft and then applying a solution of chalk and alcohol. As the alcohol evaporates it leaves a chalk coating which becomes stained by the oil held in the cracks that are invisible to the naked eye. These cracks are also repaired by arc welding.

This method of building up large crank shafts is practically the only reliable way of repairing them. The only alternative is to replace them with new shafts, but that would cost many times more than the repair job. Shafts repaired in this manner give service equally as good as new shafts.

A. F. DAVIS.

Vice-President
The Lincoln Electric Company
Cleveland, Ohio

One Way to Cut Mica for a Commutator "V" Ring

LET *A*, Fig. 1, be the diameter of the outer edge of the ring in question, *B* the diameter at apex of the ring, and *C* the width of the face which bears against the commutator bars.

Probably, the best procedure is to make a template out of a piece of paper by laying off the diameters *A* and *B* parallel, and separated by a distance equal to *C* and with the center of diameter *A* where a perpendicular line will intersect diameter *B* at its center.

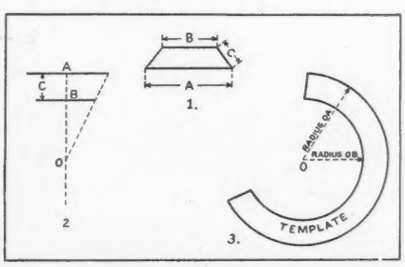


Fig. 1.—From the ring in question take the measurements indicated hereon. Fig. 2—Radii lengths for the template are thus obtained. Fig. 3—From the radii determined as in Fig. 2, the template is laid out with a compass or a pair of dividers.

Continue this perpendicular until it intersects a line drawn through the terminal points of the two diameters at the point *O*, as in Fig. 2. Then with point *O* as a center and with radii equal to the length on the perpendicular from *O* to line *B*, and from *O* to line *A*, a template of the proper shape may be drawn with a compass or a pair of dividers.

However, it is best to cut this template a little large so that any possible error may be taken care of. The template for the inner face may be made the same way, but in this case the diameter *B* at the apex will be the larger of the two.

When the mica ring has been cut to the form of the template, and it has been heated and curled to the proper shape, form a lap joint where the two ends meet by cutting away the mica from the bottom for ¼ in. or so on one end, and from the upper side for the same distance on the other.

When taking mica or mica-nite from the sheet cut it so that the label will remain on the corner last used, thus till the last scrap is needed there will be a label on it giving its thickness and type.

CARL A. WAGNER.

Denver, Colo.

Factors that make the difference between a good rewind job and a poor one—*The first article of a new series.*

PROPERLY BANDED ROTORS

Mean Fewer Breakdowns, Longer Life, and Less Trouble

By A. C. ROE

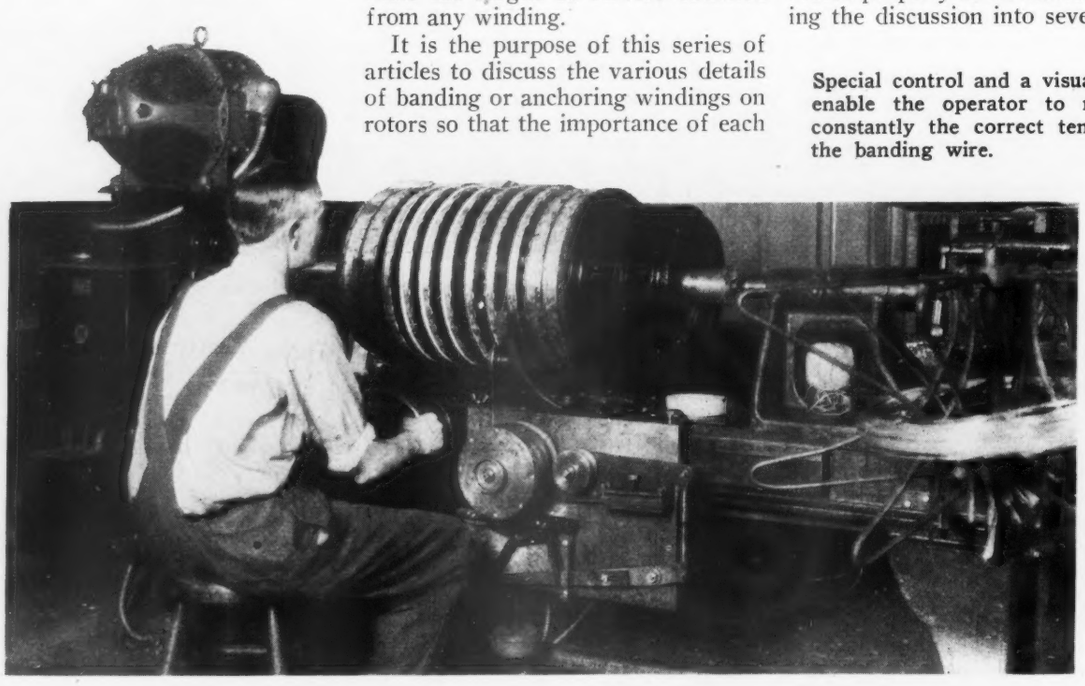
Renewal Parts Engineering Department
Westinghouse Electric & Manufacturing Company
East Pittsburgh, Pa.

ELECTRICAL windings of rotors must be held securely in place against the effects of vibration and centrifugal and magnetic forces, by the use of steel wire bands, various types of wedges, or both. Thus, in the design of rotating electrical apparatus in which the rotating element carries a winding composed of coils wound into open or partially-closed slots, the problem of retaining and bracing the winding is studied by both mechanical and electrical engineers. All sections of the windings, including the core, are investigated to determine the best means of bracing, supporting, wedging, and banding to make a solid winding.

The problem of retaining the windings begins with the type of front and rear coil supports to be used; the slot insulation and wedge are also a part of the problem—likewise the insulation between the top and bottom layers of coil ends. The insulation applied to the coils is considered under "banding," as the proper selection and application of the various details determine the length of service obtained from any winding.

It is the purpose of this series of articles to discuss the various details of banding or anchoring windings on rotors so that the importance of each item of the complete assembly may be generally understood and sufficient data taken when stripping any armature to permit banding the rewound armature with factory methods and materials.

To cover the subject of banding rotors properly necessitates subdividing the discussion into several parts,



Special control and a visual signal enable the operator to maintain constantly the correct tension on the banding wire.

according to the following sequence of application:

1. Insulating materials used in banding and retaining windings.
2. Types of coil supports and methods of insulating.
3. Slot insulation.
4. Insulation between layers of coil ends.
5. Insulation used on the armature coils in conjunction with banding.
6. Retaining wedges.
7. Insulation under bands.
8. Size of wire and width of band.
9. Band heating.
10. Band tension.
11. Cold-running bands.
12. Hot, temporary-running bands.
13. Segmental bands.
14. Methods and materials used to fasten bands.
15. Soldering bands.

At first glance one may receive the impression that the subject of banding is being made to appear complicated. On the contrary, the intention is to show the importance of all phases of banding, so that rewound apparatus will have the coils installed and fastened in place in a manner comparable to the original factory winding.

Improperly-banded rotors result in loose coils, band heating, and chafing of coil insulation. In fact, a considerable proportion of the armature failures in service can be traced to some infraction of the proper methods of banding, or the use of improper and inferior materials.

The type of material used for clips, the grade and kind of band wire used, width of bands, number of layers of bands, dividing wide bands into sections insulated from each other, number and spacing of the clips—all of these affect band heating. If care is not taken when stripping an armature to obtain all these details, or if the proper data are not available to permit correct banding, there is a possibility of the bands heating and destroying the winding.

Correct band pressure is of great importance and the large electrical manufacturers have developed special banding lathes of the type shown in the illustration in which the band pressure can be adjusted to suit the type of winding, and maintained by means of special control and two lights. A green light indicates that the pressure is being maintained at the desired value, whereas a red light indicates a change of pressure, which the operator must adjust to the proper value.

An important feature of the banding machine shown is that the pressure is obtained by retarding a drum, and not by clamping the wire between two blocks. This means that the wire is not heated from the friction of passing through tension clamps.

As an example of the careful attention paid to details in banding rotors at the factory, it is the practice, when wire-wound armature coils are used, to place thin strips of cementing material between the wires of the coil at the diamond ends, under the fishing tape, to prevent their collapse under the pressure of the coil end bands.

The type of coil, type of motor, and the conditions under which it operates all affect the method employed in banding the rotor.

Numerous studies made of armature failures after rewinding have indicated that in the majority of cases improper banding was the cause of the breakdown. By improper banding we mean that one or more of the essential details were omitted or slighted.

A recent case of improper banding causing a high percentage of armature failures, came to light after an extensive study of service records and the methods used in the repair shop. The investigation was carried on by an employee of the plant that was having the trouble, and his report stated that factory-wound armatures had considerably longer life than their own rewinds. The cause for this difference was attributed to loose or poor banding, and proof of this was found on the rewound armatures in the winding room.

As a result of this investigation the manufacturer of the motors was asked to give detailed recommendations for the proper winding, testing, treating, and banding methods to be employed with the various types of motors, in order to obtain a rewind life that was more comparable with that obtained from factory wound armatures.

Detailed discussion of the important factor in banding rotors will be presented in succeeding articles. The first will appear in an early issue.

Readers are asking for information on organization for maintenance. . . . Next month they will be given the details of the maintenance organization of the Corning Glass Works.

Using Graphite in Bearings to Improve Operation

IN his interesting article which appeared under the above heading in the June, 1930, issue of *Industrial Engineering*, Mr. Gergens confines his experiences and suggestions largely to graphite in oil. The several applications which he mentions of graphite as a lubricant are a few of its many uses as a lubricant, for cooling bearings, and so on.

In addition to the use of graphite in oil, my experience has been that its use with plain greases is of just as much value to engineers and mechanical men as when used with oil, as it increases the lubricating qualities of the grease.

Mr. Gergens mentions deflocculated graphite, but does not say anything about having used flake graphite which, so far as my acquaintance with the subject goes, is more generally used. Flake graphite of very high quality can be purchased in the form of large flakes for use in heavy machinery, or as a fine or powdered flake for more delicate and closely-fitting parts. I have seen demonstrations where graphites, particularly those of the amorphous variety, will pack; this action is impossible in the case of a very high grade, flake, lubricating graphite. Then, too, my experience that too-finely ground graphite has too much of a tendency to work out with the oil is borne out by that of others.

The reason I have brought this matter up is that someone might feel that in order to obtain the good results mentioned by Mr. Gergens it is necessary to use the graphite described by him, whereas I have always found that the best results are obtained by using a natural flake graphite of high quality.

J. M. WILLITS.
Manager, Lubricants Sales Department, Joseph Dixon Crucible Company, Jersey City, N. J.

Machine-Made Belting

Some Details of the Process of Making Tension-Cemented Leather Belting, a Product Recently Announced

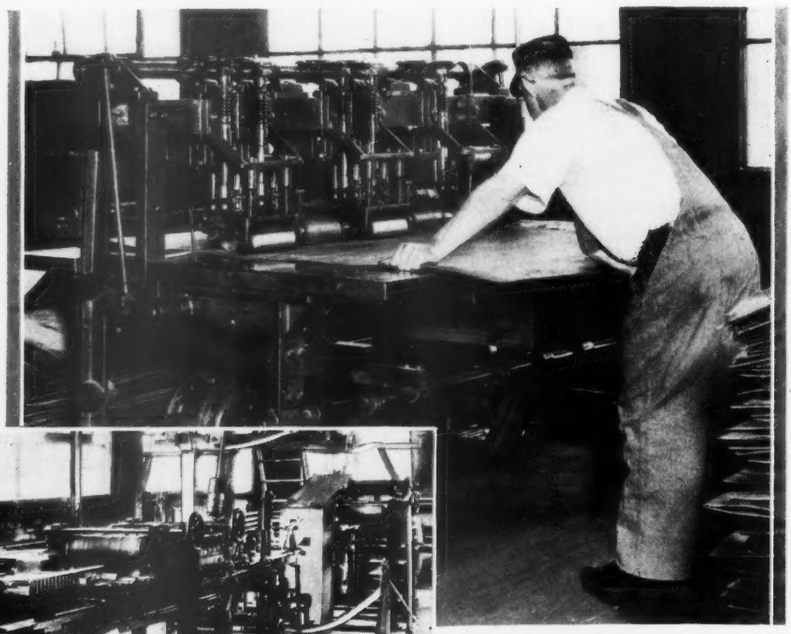
IN the Equipment News section of July INDUSTRIAL ENGINEERING announcement was made of "tension-cemented" flat leather belting, a recent product of the Graton & Knight Company, of Worcester, Mass. We now are able to give details of the process of manufacture and illustrate two of the machines used.

Variation in the thickness of a "belting bend" taken from the center portion of a heavy steer hide, is from 8/64 to 7/32 inch. A machine, illustrated, has been designed and built, and is used by Graton & Knight, to automatically stamp the thickness to an accuracy of 0.008 in. in 185 places on a bend of average size. This operation, obviously, has a controlling influence upon the following operations of cutting the bend into belting strips, matching, and fitting.

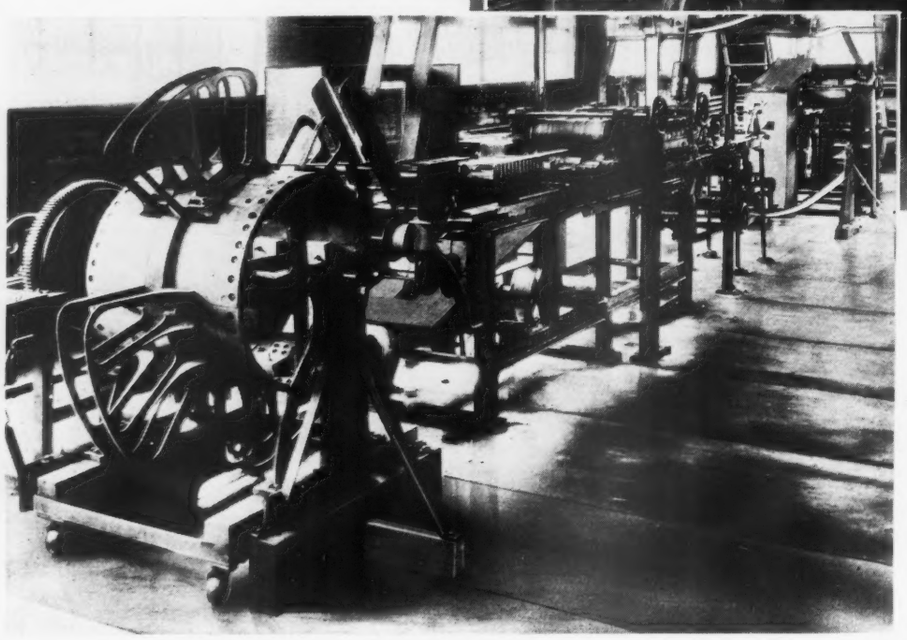
A battery of machines shaves the high spots of matched belting strips, an operation necessary in securing belting of uniform thickness.

The laps of single belting and the flesh side of the leather in double belting have to be treated to raise the fiber so that the cement will penetrate and hold fast to the finished belt. Machinery is employed for this operation, also.

It is from the next operation, also performed by special machine, that the belting takes its name. This machine, illustrated, applies the cement uniformly and does the pressing in a continuous operation while the belt is under controlled tension. The objectives of cementing under tension are to secure a cement line of the same length as the belting; and to stretch the belting so that after installation frequent take-ups will not be necessary.



On the "sorting" machine illustrated the thickness of hides, to an accuracy of 0.008 in., is stamped automatically in 185 places. Each "belting bend" is run through the machine.



The tension-cementing machine. Cement is applied and the pressing is done in a continuous operation, while the belting is under controlled tension.

QUESTIONS *and* ANSWERS BY READERS

Inspection Schedule for Electric Elevators

Four electric elevators, two for freight and two for passenger service, are to be installed in our plant, and will be under my care —which is a new experience. I assume that some parts require inspection more frequently than others, but do not know enough about it to work out a trustworthy schedule. I shall appreciate it if readers will suggest an inspection routine for the various parts of these elevators that will enable me to keep them in the proper condition.

Chicago, Ill. **W. A. H.**

Demagnetizing Large Dies

We are having trouble with magnetism in some punch press dies that measure about 14x22x5 in. A demagnetizer that will take care of smaller dies is in use in our machine shop, but so far I have not been able to treat the larger dies so that small pieces of scrap iron will drop off. I shall appreciate it if someone will give me directions for building an outfit that will completely demagnetize these dies. We have available 115-volt, 60-cycle, single-phase, and 230-volt, 60-cycle, three-phase current.

New York, N. Y. **T. A. G.**

Choice Between Single-Ply and Double-Ply Belting

A large number of belt drives of less than 5-hp. to 75-hp. capacity are in our plant. All of our motors are the squirrel-cage type, started by compensators, but a few small linestart motors will probably be put in later. For some reason it has been the policy to use two-ply leather belts whenever possible, instead of the wider single-ply belt required to carry the same load. This practice has enabled us to use narrower belts and pulleys, which is of some advantage, but I am wondering if it is the best practice. Would we gain anything in increased life or lower maintenance by using single-ply belts whenever practicable on future installations? How can one tell whether to use a single- or a double-ply belt for a given drive on which either might be used?

Newark, N. J. **F. J. S.**

How Can Sweating of Outside Walls Be Eliminated?

We have a five-story brick-and-steel-construction mill building with a stairwell about 45 ft. long and 20 ft. wide in one corner. This stairwell is not heated and we experience considerable trouble from sweating of the outside walls in winter. At present we have to repaint the walls every spring. A 6-in. cast-iron toilet vent in one corner of the stairwell sweats so badly that the platforms become slippery and dangerous. Heating the well would overcome the trouble, but it would be rather expensive and I am wondering if other readers have had the same trouble and have devised some method of treating the walls and pipes that will prevent sweating. Your suggestions will be much appreciated.

Easthampton, Mass. **J. F. W.**

SWEATING of the walls of the stairwell mentioned by J. F. W., is primarily due to lack of proper ventilation. Heating the stairwell would not overcome the trouble without proper circulation. I suggest that a small radiator be placed at each floor, and that one or two ventilators, provided with dampers having fusible links be installed on the roof over the stairwell. This arrangement, with the heating at the floors, will cause circulation that will overcome the condition.

In my opinion no paint treatment will properly insulate the brick wall: this is the wrong method of attack.

Engineer, New York, N. Y. W. P. KEARNEY.

REFERRING to J. F. W.'s question, we have had good success with insulating cork paint on walls and ceilings that sweat.

The paint is prepared by adding sufficient ground or pulverized cork to a good lead paint to produce a mixture of thick, creamy consistency. It should, of course, be well stirred, and a small amount of drier added. The paint is not difficult to apply, and adheres well to brick or ironwork if the surface is in the proper condition. Ironwork should be given a priming coat of red lead in oil before applying the cork insulating paint.

It is extensively used by the Navy for painting the inside of ship hulls and compartments to prevent condensation of moisture.

If J. F. W. wishes further information, I believe he can obtain it from the Chief of the Bureau of Construction and Repairs, Navy Department, Washington, D. C.

CHARLES H. WILLEY.
West Concord, N. H.

Combining Advantages of Group and Individual Drives

We are rebuilding a large part of our plant, and a difference of opinion has come up regarding power drives for our machines. They are well suited to group driving, which has been used heretofore, but the "forest-of-belts" appearance is objectionable. Under our conditions I do not favor individual drive throughout, and I am wondering if we could obtain some of the advantages of both types of drive by some such scheme as driving the machines on one floor from a lineshaft on the ceiling of the floor below, or by mounting our lineshafts behind the machines, on the same floor.

If any readers have used either of these methods, or have had experience with other arrangements, I wish they would give me the details and let me know what the results have been. **P. M. J.**

Cleveland, Ohio.

REFERRING to P. M. J.'s question, it would be easier to advise him if one knew the type of machinery to be driven and some other facts, such as the frequency with which the layout is changed, how valuable floor space is, and so on.

The big disadvantages of placing shafts below the floor to drive machinery above it are: The necessity of cutting holes, which weaken the building construction and allow dirt to fall onto the machines and work below; difficuty of avoiding beams and securing the desired layout; and the extra trouble involved in working on belts, which has to be done on two floors.

Lineshafts located behind the machines on the same floor occupy valuable floor space, involve short-center drives, and require careful guarding,

ANSWERS *to* QUESTIONS

but are accessible and easy to work on.

In many cases the location of driving pulleys, or the necessity of providing sufficient clearance for working, determine the location of the lineshafts, or at least the machine countershaft. Unless provision must be made for crane service, or the space above machines must be left clear, as with woodworking or sewing machines, I believe that P. M. J. will have a hard time to make the elimination of the "forest of belts" pay a cash return, if indeed it is not quite a little more expensive than the conventional arrangement. H. D. FISHER.

Plant Engineer,
New Haven Pulp and Board Company,
New Haven, Conn.

Is Back-Torque Operation of Slipring Hoist Motor Harmful?

We are having trouble with the brake of a 75-hp. slipring induction motor that operates a hoist. In order to save the brake the hoist operator was instructed to lower the skip by applying current in the hoisting position. The question has come up as to whether the motor may be injured or partially burned out.

After the hoist had been operated in this way for some time I felt the motor, and found the temperature was about normal, but the resistance grids were very hot. I should like to know whether there is any danger of injuring the motor by operating it in this way, and whether it can be considered good practice.

Flin Flon, Man., Canada. **A. P.**

REPLYING to A. P., the method he is using to lower the skip is proper and will not injure the motor. However, it is evidently being applied in the wrong way. He states that the operator is applying current in the hoisting position. This is evidently an error, as the controller would have to be reversed in order to lower the skip.

The heating of the resistance grids is due to the fact that the operator is not opening the controller to its running position, and is thus leaving the resistance in the rotor circuit. This is a frequent error among operators who have not been properly instructed in the handling of slipring motors.

When a motor of that type is used for lowering a load the action of the controller is exactly the reverse of what would be expected from its behavior when hoisting. In hoisting, the motor reaches its maximum speed with the controller wide open and the rings short-circuited. If the controller is reversed and the load lowered, the maximum speed is obtained with the resistance all in circuit, and the speed reduces as the controller is opened until the motor approaches its synchronous speed. It will maintain this unless the load is heavy enough to "pull it out," in which case it would have to be helped by the brake.

When operated with the controller wide open, the lowering speed will be slightly greater than the hoisting speed. Should it be desirable to lower at a higher speed it will be necessary to install a lowering resistance heavy enough to handle the secondary current without overheating.

If A. P. will think of this motor as being simply a special form of transformer, rather than a motor, he will readily understand the reason for its action under the two different conditions of operation.

Mexico, Ky. R. R. SCHELLENGER.

WHEN a wound-rotor hoist motor is reversed, as described by A. P., it assumes the role of a generator producing an alternating electromotive force. The field is supplied by the polyphase stator winding, whereas the skip acts as the prime mover. The generated electromotive force in the rotor winding at the instant the stator is connected to the line has a frequency which bears the following relation to the stator frequency:

$$F_r = (N_2 - N_1) \div N_2 \times F_s$$

where

F_r = rotor frequency
F_s = stator or line frequency
N_2 = r.p.m. of motor (synchronous)
N_1 = r.p.m. of rotor in opposite direction

As the rotor slows down the frequency decreases until at standstill it is equal to line frequency. When the stator is connected to the line and the rotor circuit is closed through the grids it is equivalent to placing a load on an a.c. generator, and the load current depends upon the value of resistance in the grids. The lower the resistance the more current will flow in the circuit, and the higher will be the temperature rise. The energy thus expended is supplied partially by the stator winding and partially by the transfer of kinetic energy from the skip.

The comparatively low resistance of the grids results in a very high rotor current and subsequent heating of the grids. The current value in the rotor winding is, however, the same as in the grids in most cases, and it will be found that the rotor heats up as well as the grids. As most of the energy is derived from the skip, the stator current is comparatively low and no serious heating is to be expected.

The use of a hoist motor for braking purposes in this manner is not dangerous, but the maximum allowable rotor current should not greatly exceed the full-load rotor current specified by the motor manufacturer. If this condition is maintained there is no possibility of seriously heating the rotor winding. If this is not done the winding may be injured.

In order to meet this condition the resistance of the grids must be increased to the necessary value. However, it will be found that the necessary secondary resistance will be too great to produce sufficient braking action, and for this reason it can be said that such operation cannot be considered as good practice.

Chief Engineer, S. S. WOLFF.
American Electric Motor Company,
Cedarburg, Wis.

Is the Distance Between Centers Suitable for This Drive?

Plans have been made to install a 150-hp., 580-r.p.m. motor carrying a pulley 24 in. in diameter to drive a lineshaft at 278 r.p.m. A 50-in. pulley will be used on the lineshaft, and we will use a composition belt 3/8 in. thick and 18 in. wide. As now specified, the center distance between the motor shaft and lineshaft is 12 ft. 6 in., which I feel is too short for a drive of this size. If I am correct in this, what is the minimum center distance that would be satisfactory? As our space is limited, it may not be possible to use the desirable center distance. In that event, what would readers suggest as the most suitable type of drive?

Newark, N. J. **L. W.**

WITH reference to L. W.'s question, in any belt drive installation the distance between centers should be great enough to insure that the arc of contact of the belt on the smaller pulley will not be so small as to cause undue slippage. With too small arc of contact, the belt must be run with excessively high tension.

A number of articles on this subject have appeared in INDUSTRIAL ENGINEERING. An authoritative article entitled, "Power Transmission by Leather Belting," by William Staniar, was published in the January, 1929, issue. In this article a tabulation was given of minimum center distances for belt drives, based on the power transmitted and the reduction ratios. For a 2.08:1 speed reduction the table indicates that for transmitting between 125 and 149 hp. the distance between centers should be about 22 ft., and for a drive transmitting between 150 and 200 hp. the distance should be 26 ft.

Some value between these two figures should be about right for L. W.'s drive. A center distance of only 12 ft. 6 in. evidently would not conform to the best practice.

If space is at a premium and a short-center drive is wanted, why not consider a silent chain drive? An article by William Staniar giving considerable data on chain drives was published in the September issue. R. F. EMERSON.

Industrial Engineering Department,
General Electric Company,
Schenectady, N. Y.

EQUIPMENT NEWS

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these devices, which are designed to improve plant operation or reduce operating and maintenance costs.

Nathan Mechanical Lubricators

FIVE different types of mechanical lubricators for industrial applications have been placed on the market by the Nathan Manufacturing Company, 250 Park Ave., New York, N. Y. Among the features of these lubricators are: ease and accuracy of regulating the quantity of lubricant delivered; positive operation under all conditions; simple mechanical construction eliminating all valves; uniform lubricant delivery at slow speeds, and wide range of pressures.

Type D lubricator, illustrated, has a positive piston mechanism and visible piston indicator. It is arranged for from one to 38 feeds, and is equipped with an oil reservoir and either ratchet or rotary drive for right-hand or left-hand rotation or both. The necessity for using a sight-feed instrument is eliminated and the machine is recommended for machine tools, presses, and other equipment where an attendant is not available to check the amount of lubricant being delivered. A similar type, the model DS1, is distinguished from the type D by the sight feeds provided for observing the oil feed in the form of drops. It is advocated only for cylinder lubrication and extreme cases, because the other models are positive in amount of lubricant delivered and operation. The model D lubricator will work against pressures from 500 to 2,800 lb. per sq. inch.

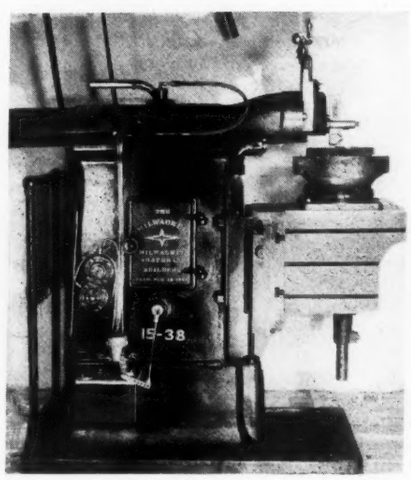
Smaller lubricators are available in types P, PS, and PK. The type P lubricator has from one to eleven feeds, but

is not supplied with an oil reservoir. It is also suitable for ratchet or rotary drive and may be built into small or medium-size engines or machines.

The type PK lubricator is similar in construction to the type D, but is smaller and more compact and especially adapted for small machine tools and equipment.

Quigley Company Changes Name

QUIGLEY FURNACE SPECIALTIES COMPANY, 56 West 45th St., New York, N. Y., announces a change in name to the Quigley Company, Inc. Originally, this company dealt in furnace specialties only, but in recent years it has been engaged in the manufacture and marketing of a number of additional products used in a wide variety of industries. "Industrial Specialties" more aptly describes the nature of the business.



Lincoln 400-amp. Gas-Engine-Driven Welder

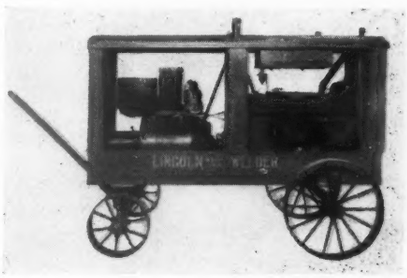
A GAS-ENGINE-DRIVEN welder with a rating of 400-amp. has been placed on the market by The Lincoln Electric Company, Cleveland, Ohio. The growing use of larger-sized electrodes led to the development of this larger machine which is designed for field work in all kinds of construction work such as structural, oil and gas lines, field repairs, ship repairs, ship building, and so on.

It is rated at 400 amp. with a current range up to 500 amp. and is of variable-voltage, single-operator type, operating at 1,500 r.p.m. All control mechanism is contained in a ventilated inclosed steel cabinet with hand regulators and switches mounted on a panel which forms a side of the cabinet. The control panel contains rheostat, diverter switch, voltammeter, and wing-nut terminals for cables. The control cabinet is mounted directly over the generator for easy access by the welding operator.

This unit is driven by a six-cylinder engine whose S.A.E. rating is 33.75 hp.; brake horsepower at 1,500 r.p.m., 55. It is equipped with an automatic throttle control.

Provision is made by means of a time delay to keep the engine going at full speed when the arc is momentarily broken, and it will not slow down for a predetermined time interval after breaking the arc, thus permitting the operator to change electrodes, etc., without affecting the speed.

A metal cover with removable metal incloses the welder, the sides of which are inter-locking so that the cover and sides can all be locked with a padlock and key.

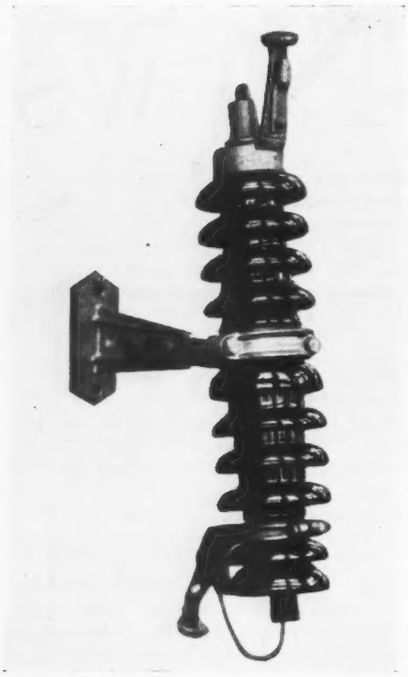


Wheels are optional, however, when furnished they are of 6-in. tread, a fifth wheel is provided for short turning. Overall dimensions exclusive of wheels are 104x32x58 in.; the weight is approximately 3,500 pounds.

Champion Self-Insulated Expulsion Fuse

OUTDOOR expulsion fuses for 7.5 to 37 kv. service have been announced by The Champion Switch Company, Kenova, W. Va., a 37-kv. type being pictured.

It is claimed to be a distinct departure from the older design in that the fuse tube proper is carried in a wet-



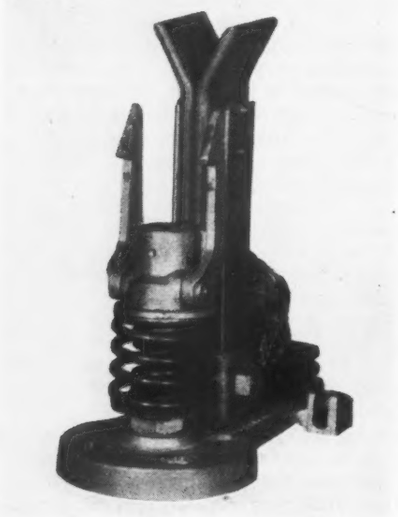
process corrugated bushing in turn mounted on a malleable-iron clamp, thus eliminating the usual supporting insulators.

The fuse tube projects beyond the porcelain bushing securing a long air gap after the fuse blows. The upper end of the tube carries a cap easily removed for inserting fuse wire.

Delta-Star Floating Contact for Disconnecting Switches

DELTA-STAR Electric Company, Chicago, Ill., has developed an improved floating contact for vertical break, outdoor type, gang-operated disconnecting switches.

Wide flares guide the blade when closing. The combination buffer and lock latch absorbs the closing blow and locks the blade in contact against rebound or opening on short circuit.

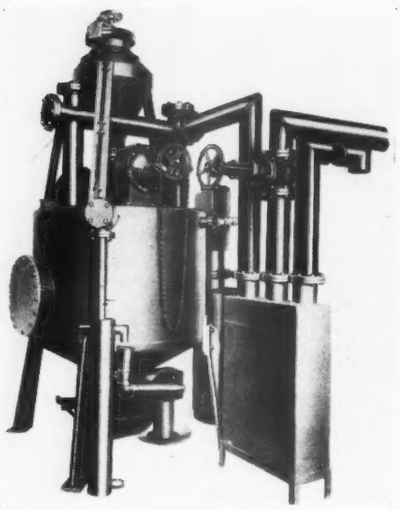


Oxweld Type NA-3 and NA-4 Acetylene Generators

OXWELD ACETYLENE COMPANY, 30 East 42nd St., New York, N. Y., has placed on the market two improved types of non-automatic stationary acetylene generators for supplying large volumes of acetylene. These generators are each made in two sizes having 500 lb. and 1,000 lb. carbide capacity. They are designed for large industrial plants where oxwelding and cutting are used extensively and where oxygen and acetylene are piped to stations convenient to operators.

Type NA-3 generator, shown in the illustration, is for plants using low-pressure welding and cutting apparatus and delivers to a storage holder which is weighted to supply acetylene to the shop piping system at a pressure of 20-in. water column.

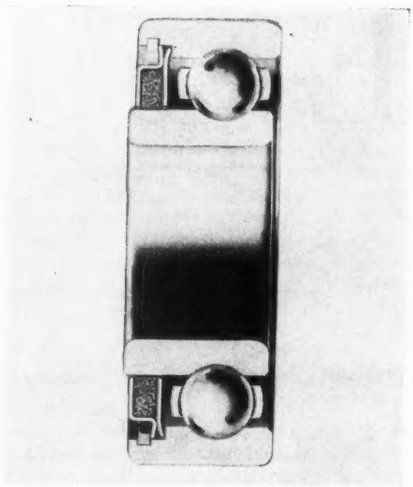
Type NA-4 is similar to the Type NA-3 with the addition of an oxweld



automatic booster system to deliver acetylene to the shop piping system at pressures not to exceed the permissible limit of 15 lb. per sq. in. The booster system consists of a booster pump, pressure regulating, by-pass valve, pulsation tank, mercury seal, hydraulic back-pressure valve, electric motor for driving the booster, and power transmission equipment. The booster unit may be had with a capacity suitable for the particular installation.

S K F "Felt-Seal" Ball Bearing

THE cross-sectional view shows the constructional features and design of the "Felt-Seal" ball bearing introduced by S K F Industries, Inc., 40 E. 34th St., New York, N. Y. The bore and outside diameter are ground to international standard dimensions and tolerances, the same as the corresponding standard single row bearings. The width is slightly greater to accommodate the felt seal.



The seal consists of a dished inner steel plate, a removable felt, a dished steel end plate, and a split steel ring fitted into the groove in the outer race to hold the assembly in place.

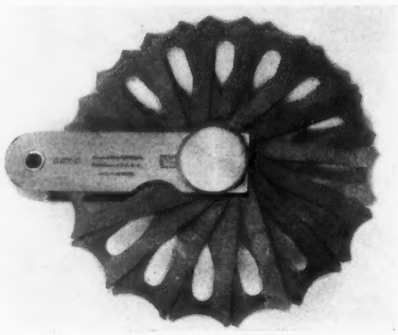
An outstanding feature of the bearing is the ease with which the seal may be disassembled at any time and new felts applied.

Browne & Sharpe Fillet and Radius Gages

SOME very unique features are embodied in a series of fillet and radius gages announced by the Brown & Sharpe Manufacturing Company, Providence, R. I. The tools simplify the rapid checking of fillets and radii.

Concave and convex radii of the same size are included on the same blade—this double-ended feature reduces by one half the number of blades necessary for a given range. A large clamp nut locks the blades securely in any desired position.

Two styles of gages are available. Nos. 627A and 627B have a blade form which is particularly adapted for checking fillets and radii in corners or against shoulders. No. 627A has a range from $\frac{1}{32}$ to $\frac{17}{64}$ in. by 64ths and No. 627B from $\frac{9}{32}$ to $\frac{33}{64}$ in. by 64ths. Nos. 627C and 627D are especially useful in laying out forming tools and similar work. No. 627C has a range from $\frac{1}{32}$ to $\frac{1}{4}$ in. by 64ths, and No. 627D from $\frac{17}{64}$ to $\frac{1}{2}$ in. by 64ths.

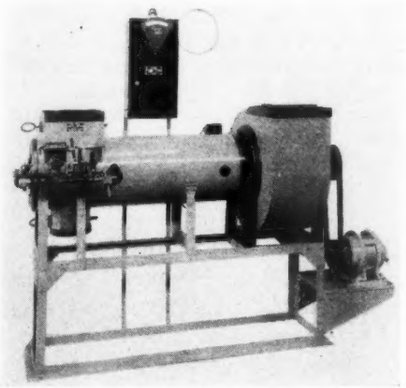


Maehler Industrial Oven Heater

AN industrial oven heater, known as the Maehler-Universal Heater, has been developed by the Paul Maehler Company, 2208 West Lake St., Chicago, Ill. Air from the oven with its vapor content passes through the heat flame where all explosive gases developed in the oven are incinerated.

The use of low pressure heated air places the heater outside the oven where it is accessible at all times during operation.

The circulating medium is drawn from the top of the oven by a high-temperature suction fan located at the exhaust end of the heater, passes through the heater and returns through the fan to the bottom of the oven. The fan being of the suction type drawing the air through the heater, and an independent throat and air intake for gas combustion being provided, a soft, quiet, visible burner flame is produced and the use of a visible pilot and automatic electric ignition is possible. An adjustable fresh air inlet at the intake end of the heater permits the introduction of fresh air into the heater at room temperature, when desired.



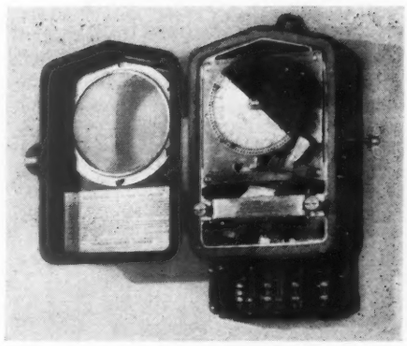
Sangamo Electrically Wound Time Switch

THE time switch recently introduced by the Sangamo Electric Company, Springfield, Ill., is a development of the Sangamo—now Hamilton-Sangamo—electrically wound clock put on the market several years ago.

Switches are available for any commercial voltage and frequency. Motors for a.c. and d.c. units are not interchangeable, wherein lies the difference between the two types.

Essentially the clock mechanism is that of a standard clock, the main spring of which is kept wound to a constant tension by a small, noiseless motor. The escapement is of the type used in standard watches built by the Hamilton Watch Company.

These features insure switch operation through periods of current interruption without in any way affecting the time-keeping of the clock mechanism. A 24-hr. dial is supplied, in the outer edge of which are two rows of small holes, there being 96 holes in each row. These therefore represent 15-min. intervals and pins may be inserted, wherever desired, which project through the dial and function to trip levers that release the mechanism which tilts a mercury tube. In brief, the switch may be employed for opening and closing a circuit once every twenty-four hours or as often as every fifteen minutes during a 24-hr. period, depending on the number of pins placed in the time dial.



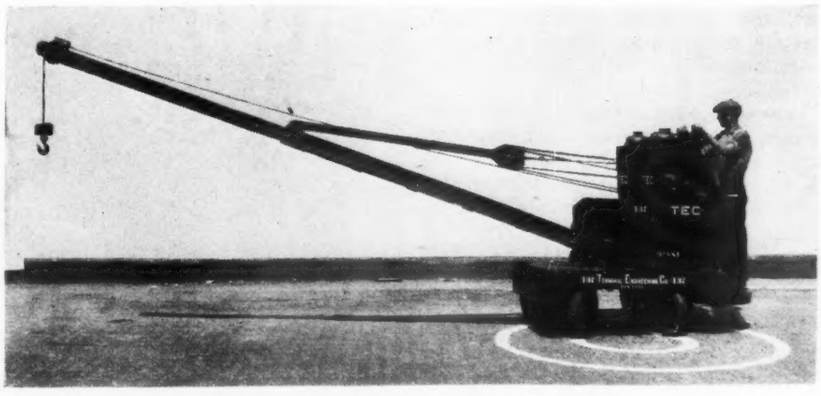
Terminal Heavy-Duty Crane

A HEAVY-DUTY crane, suitable for indoor or outdoor use, has been placed on the market by the Terminal Engineering Company, New York, N. Y. The capacity of this crane is 3,650 lb. at a distance of 2 ft. from the end of the chassis, or 750 lb. at a distance of 14 ft. from the end of the chassis. The boom is telescopic over a distance of 6 ft. The boom and hook are operated independently from two separately driven hoist units, each with its own motor and controller.

All four wheels are driven by individual motors. In order to give a maximum counterbalancing effect, the machine is so designed as to concentrate as much weight as possible over the wheels away from the load.

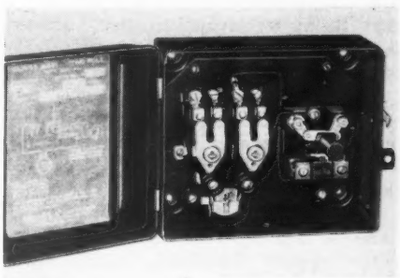
The maximum height of lift is 17 ft. 6 in. on the standard model, although longer booms may be furnished upon request. The machine can pass through doorways as low as 72 in. when the boom is lowered.

Power is supplied to the crane from a storage battery which is large enough to operate an electric magnet, as well as to perform the propelling and hoisting duties. The battery is carried in one unit in a steel container and can be changed by using an overhead hoist.



Industrial Controller Two-pole A.C. and D.C. Starters

THE Industrial Controller Division of the Square D Company, Milwaukee, Wis., announces two starters; the Class 8531 a.c. two-pole, and Class 8731 d.c. two-pole for across-the-line starting of small motors. These starters have silver contact points, a floating contactor armature and are provided with two-pole, double-break contacts. The overload relay is of the thermal time-limit type with external reset button in the cover. Low-voltage release is provided with two-wire control and low-voltage protection is provided with three-wire control.



Type B-1 is for two- or three-wire control and type C-1 for two-wire control with a three-point switch in the cover for manual, off, and automatic operation.

The a.c. unit is for use with motors up to 1½ hp. at 110 volts and up to 3 hp. at 220 volts. The d.c. starter is for use with motors up to 1 hp. at 115 volts and 230 volts.

Nischan Draw Punch

R. M. SWISHER COMPANY, general sales agent, Hammond, Ind., is marketing the draw punch for increasing knockout sizes now being manufactured by Nischan Products,

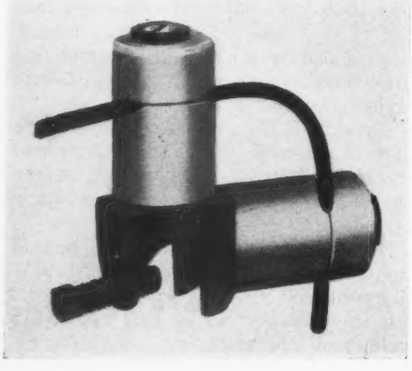
Inc., East Chicago, Ind. This punch, which is built in three sets; one for ¾-in., 1-in., and 1¼-in. holes, one for 1½-in., 2-in., and 2½-in. holes, and one for 3-in., 3½-in. and 4-in. holes, has four cutters and is equipped with semi-floating bearings. Eccentric holes, it is claimed, can be made by bending the moving punch over to one side of hole.

Fullman "Bull Dog" Insulator Supports

A COMPLETE line of insulator supports, designated "Bull Dog," is being manufactured by the Fullman Manufacturing Company, Latrobe, Pa. These devices are intended for securely attaching porcelain and glass insulators used in open wiring to steel framework of mill-type buildings, bridges, and so on.

These insulator supports may also be used in combination with pipe hangers for attaching conduit to steel members. Special clamps or clips are provided for this purpose.

Attachment to the steel member is made by means of the set screw shown in the support illustrated. In this view two No. 5½ split insulators with a No. 400 insulator support are shown



assembled in making a 90-deg. bend around a member. For ¾-in. conduit, a No. 461 pipe hanger is used with a No. 401 insulator support. The line includes insulator supports, varying in size, bearing designations, No. 400, 401, 402, and 403. The lower number corresponding to the smallest size in the line.

Lubricating Equipment "Trabon" Progressive System

THE "Trabon" system, introduced by the Lubricating Equipment Company, 31 Brady St., Detroit, Mich., can be operated with a hand- or power-driven pump mounted on the machine, or can be operated by any portable tank or gun. It consists of a complete circuit starting at the source of lubricant, touching each lubricating point, and returning to the source again. A Trabon feeder is placed in the circuit at each lubrication point. These feeders are made in various sizes so as to get different quantities of lubricant to various size bearings. Each feeder is either directly connected to the bearing or a line is run from the feeder to the bearing.

The line is always filled with lubricant, but is only under pressure when lubricating. Just as soon as new lubricant is started through the line, the first feeder shoots its quantity of lubricant to the bearing. As soon as this is done the lubricant is allowed to pass the first feeder and proceed on in the line to the second feeder, and then the second feeder shoots, then on to the third feeder and so on until the circuit is completed around to the pump.

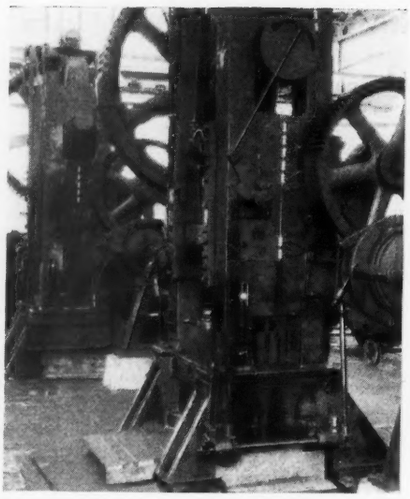
On the next shot, the lubricant is sent through the line in the opposite direction. A simple reversing mechanism at the pump operates so as to reverse the flow of lubricant. This is accomplished either automatically or by hand. The line is kept clean by reversing the lubricant each time.

The lubricant cannot pass the first feeder or any other feeder in the line until that feeder shoots to its bearing. In other words, each feeder must perform or else the lubricant cannot pass on. If any trouble develops in the bearings, or feeders, or anywhere in the line, the lubricant cannot be forced through the circuit; a positive and immediate indication to the operator that something is wrong.

When the lubricant makes a complete circuit, and is returning back into the pump, an indicator located at the pump shows that the circuit has been made.

Should the operator continue to pump without reversing the circuit, then the lubricant will pass through the line back to the pump, the indicator registering all the time.

Pump will develop only pressure sufficient to overcome resistance at bearing, in feeder and in the line. If 100 lb.



is required then the pump will deliver 100 lb.; if 4,000 lb. is required then the pump will deliver 4,000 pounds.

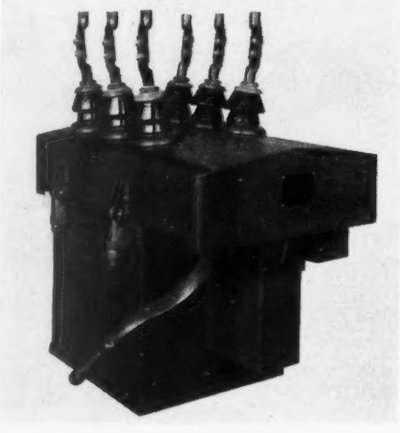
The pump is filled through a grease fitting at the bottom by means of any portable tank or gun.

General Electric Outdoor Oil Circuit Breaker

MODERATE-DUTY oil circuit breakers, designated Type FKO-27, are announced by the General Electric Company, Schenectady, N. Y., for outdoor service. They are rated at 4,500 volts, 400 and 600 amp., 25,000-kva. interrupting capacity.

Breakers are manually or electrically operated and are made triple-pole, single-throw, non-automatic, or instantaneous or time automatic. They are available for either pole or framework mounting.

The pole-mounted breaker is furnished for manual operation either at the breaker or remotely by means of an operating lever at the base of the pole. The framework-mounted breaker is furnished for either manual operation at the breaker or electric operation by means of either a solenoid or centrifugal motor mechanism in a steel housing. Bushing transformers are available.



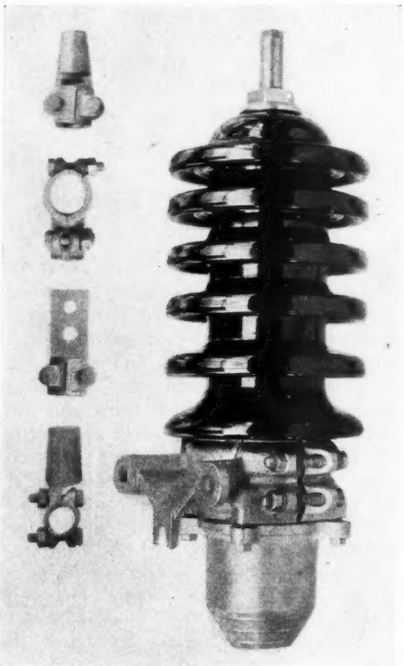
Appleton Electric Acquires National Floodlight Projectors

APPLETON ELECTRIC COMPANY, 1701 Wellington Ave., Chicago, Ill., announces the purchase from the National Appliance Company, Jackson, Mich., of its complete line of floodlight projectors which will become a part of the Appleton line of electrical material.

Delta-Star Cementless Terminator

THE Delta-Star Electric Company, 2400 Fulton St., Chicago, Ill., announces a 23-kv., 400-amp. cementless terminator for use on underground cable.

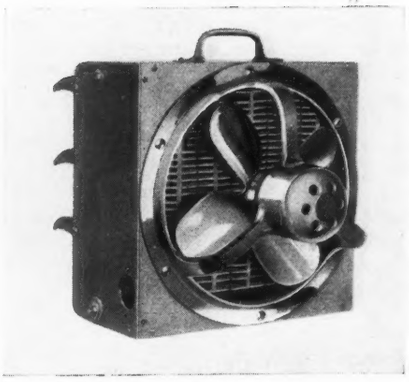
All joints are mechanically held together and sealing gaskets are provided to insure water-, oil-, and vacuum-tight joints. The aerial lugs can be disconnected for sectionalizing purposes, a few of the available styles being shown. The double bracket mounting is of high strength and insures easy installation.



American Foundry Electric Space Heater

THE American Foundry Equipment Company, Mishawaka, Ind., has recently placed on the market an electric space heater for industrial and commercial heating needs.

This unit combines the characteristics of both the steam unit heater and electric heater into one device. Its construction is simple. Special alloy heating strips are cast integrally with composite fins of aluminum alloy, making up into a single casting that will allow



an uninterrupted flow of air through its channels.

Castings of this type are then assembled in suitable number and size into a cabinet, back of which a fan operates to circulate a current of air through the heated fins and out into space where heat is desired.

Ohmite Resistance Units

THE Ohmite Manufacturing Company, 636 N. Albany Ave., Chicago, Ill., announces a series of vitreous-enameled, single-layer wound, voltmeter multiplier resistance units, with an accuracy of one per cent or one-half of one per cent—as required. These will be made in the standard sizes of 2- and 4-in. lengths with lug terminals; the former size for use up to 100,000 ohms and the latter size up to 250,000 ohms.

Link-Belt "Promal" Metal for Chains

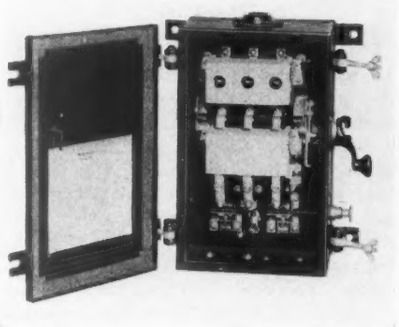
A LINE of cast-chains, said to show remarkable strength and durability, has been placed on the market by the Link-Belt Company, Indianapolis, Ind. These chains are sold under the registered trade name of "Promal."

Compared with malleable iron, Promal is claimed to have an average yield point of 45,000 lb. as against 36,000 lb.; an average ultimate strength of 65,000 lb. as against 54,000 lb.; an average elongation of 14 per cent as against 18 per cent; and a Brinell hardness of 170-190 as against 110-130.

Industrial Controller Dust-Tight Inclosures

DUST-TIGHT inclosures for its across-the-line and combination starters have been placed on the market by the Industrial Controller division of The Square D Company of Milwaukee, Wis. The illustration shows the Class 8532-S starter in the dust-tight inclosure.

These inclosures have been developed for use in such places as foundries, cement mills, flour mills, etc., and for those applications where special protection must be had against excessive dust which may impair the operation of the electrical equipment.



Cabinets are of heavy-gage steel with heavy, strap-iron mounting brackets. Cast-iron conduit flanges with live rubber gaskets are furnished on top and on the bottom of the cabinets to insure dust-tight conduit connections.

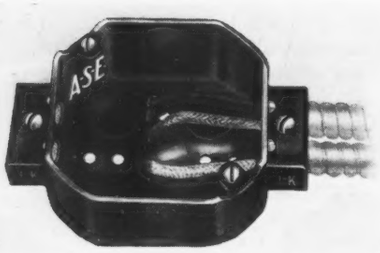
The cabinets and conduit flanges are enameled and hinge bolts and other exposed metal parts are cadmium plated.

Speer Carbon Brushes

THE Speer Carbon Company, Saint Marys, Pa., has recently announced a line of brushes for use on mill and hoist motors. This line includes grades suitable for all types of the above mentioned motors, operating under varying conditions and for all a.c. and d.c. voltages.

All-Steel Outlet Box

AN outlet box with clamps on the outside, known as the "Jay-Kay", is announced by the All-Steel-Equip Company, Aurora, Ill. The box is fitted with five 1½-in. conduit knockouts in the bottom and two in the sides opposite clamps. Clamps are fitted with



peep-holes through which to locate ABC bushing and one fitted with special shouulders to close the bushed holes when not in use. Box accommodates four leads of flexible, metallic cable which, when fitted into place, are securely fastened by turning a single screw on each clamp.

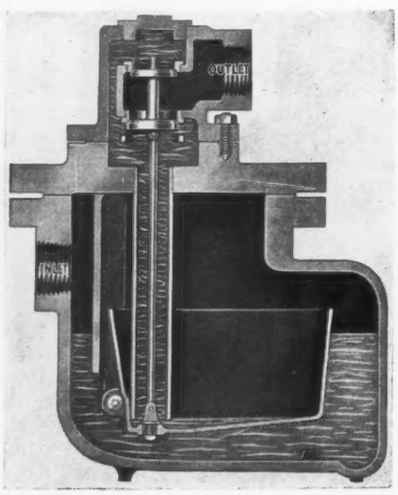
Ohmite Detachable Mounting Brackets

THE Ohmite Manufacturing Company, 636 N. Albany Ave., Chicago, Ill., announces a series of detachable mounting brackets for use in connection with various sizes of porcelain core resistors. The springiness afforded by these brackets is said to protect resistance units from shock and gives them a chance to expand or contract without strain. When the bracket is mounted on an insulated surface, there is no possibility of leakage from one terminal to another.

Strong, Carlisle & Hammond Balanced-Valve Trap

EXCEPTIONALLY large capacity at low pressure is an important claim made for the Strong balanced valve trap introduced by the Strong, Carlisle & Hammond Company, 1392 West Third St., Cleveland, Ohio. It is particularly suitable for handling condensation, gasoline, oil, caustics, and other liquids.

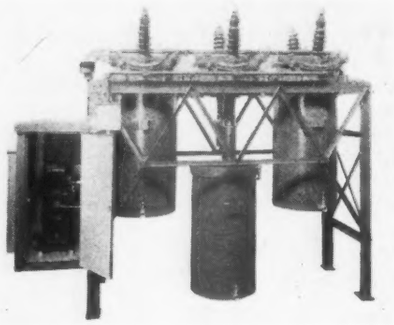
As will be apparent from the illustration, the double-seated or semi-balanced valve is operated by an open bucket hinged on a bracket extending downward from the cover. For special application other than water, the trap is fitted with valve, bucket, and other operating parts of material suitable for the conditions involved.



Sizes in which this trap is made are from 2½ to 3½ in., inclusive; operating pressures range from 0 to 50 lb.; and the capacity up to 100,000 lb. of liquid in an hour.

General Electric Circuit Breakers

A LINE of high-voltage oil-circuit breakers which conforms to the preferred system voltage ratings is announced by the General Electric Company, Schenectady, N. Y., for indoor and outdoor service. These breakers are designated Type FHKO-239. One of the outstanding features is that they can be equipped for high-speed operation on circuits where system stability is involved.

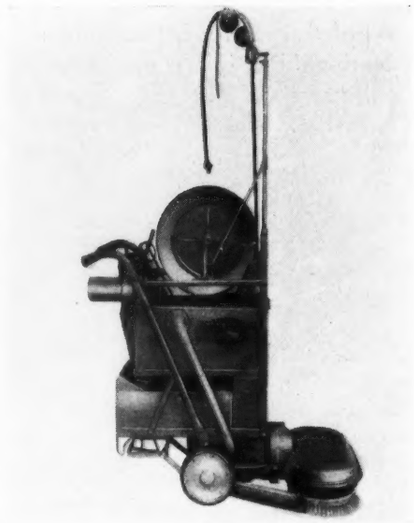


Breakers having high interrupting ratings are equipped with explosion chambers. Units rated from 15,000 to 34,500 volts use explosion chambers and rod- and segment-type contacts. At 46,000 volts and above, butt-type contacts are used. If desired, bushing potential devices can be furnished for breakers rated at 92,000 volts and above. For moderate interrupting ratings, the blade and finger-type contacts are used.

Separating chambers allow escape of gases without oil throw, and emergency vents are provided to relieve unusual pressures. Fill valves, oil drains, and sampling valves are included. All joints are gas- and oil-tight.

Finnell Combination Scrubber-Absorber

A COMBINATION scrubbing and absorbing floor machine has been placed on the market by Finnell System, Inc., Elkhart, Ind. High-speed, twin-disk brushes on the machine scour loose the grime and grit. Coincidentally, the vacuum picks up the water in which the dirt is held in suspension. There is no time for the dirt to settle on the floor before it is drawn into the tank. The floor is clean and dry in a few seconds after the machine has passed over it.

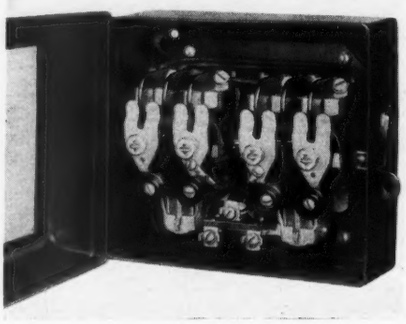


Industrial Controller Reversing Contactor

THE Industrial Controller Division of the Square D Company, Milwaukee, Wis., has brought out a small motor reversing contactor, Class 8711, as shown in the illustration. This contactor is designed primarily for operating control on small machine tools and for window opening and closing apparatus and so on. It is manufactured in two types; one for two-wire control only, and one for two- and three-wire control. The starter may be wired for controlling single-phase, three- or four-wire reversible motors, or three-phase motors rated 1½ hp. at 110 volts and 3 hp. at 220 volts.

Two double-pole, double-break contactors are mechanically interlocked and mounted side by side on a sheet-steel panel in the sheet-steel case. Contacts, both movable and stationary, are of silver. The movable contacts are easily removed without the use of tools. Contactor armatures are of the full-floating type. Wiring terminals are conveniently located at the top.

The inclosing case is 8½ in. wide, 6½ in. high and 4¼ in. deep.



Moline "Shok-Pruf" Screw Drivers

INSULATED, non-breakable screw drivers ranging in size from $\frac{5}{16}$x3 to $\frac{7}{16}$x18 in., known under the trade name of "Shok-Pruf," made of warranted steel and insulated for 2,200 volts, are being manufactured by the Moline Manufacturing Company, Moline, Ill. According to the announcement, these drivers will not break, split, or turn on the shaft. They are made without ferrules, can be pounded with a hammer, used as chisels, and will not deteriorate from use in gasoline or oil. Two types of handles, round and flat, are furnished as desired in various sets and assortments for general use or heavy duty. The electrician's set, No. 5, consists of 5 round-handled drivers in $\frac{3}{16}$x2-, 4-, 6-, 8-, and 10-in. blades. An all-purpose set, No. 8, contains 8 drivers as follows: $\frac{3}{16}$x3-, $\frac{1}{4}$x2-, 4-, and 6-in. blades in round handles; $\frac{5}{16}$x2-, 4-, 6-, and 8-in. blades in flat handles. The mechanic's set consists

of 9 drivers in the following sizes: $\frac{3}{16}$x2-, 4-, 6-; $\frac{1}{4}$x4-, and 6-in. blades in round handles; $\frac{5}{16}$x6-, and 8-in. blades in flat handles; $\frac{7}{16}$x8-, and 10-in. blades in round handles. Other sets and assortments are available in addition to the foregoing. A $\frac{7}{16}$-in. heavy-duty driver is shown in the accompanying illustration.

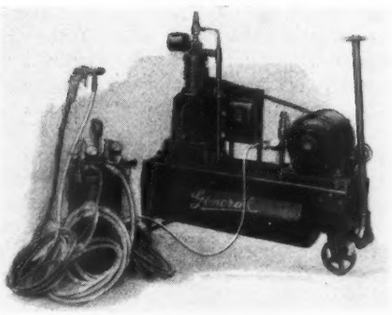
Ludlow-Saylor Woven-Wire Screens

"SPRING-STEEL", woven-wire screens are announced by the Ludlow-Saylor Wire Company, St. Louis, Mo. This material is a hard, resilient alloy for severe service on revolving-screen jackets, vibrating-screen sections, and shaking and gravity screening surfaces.

Screens can be furnished in all grades required for heavy sizing duty.

General Pneumatic Spraying Machine

THE "Victory" unit, a one-gun paint spraying machine known as No. 54, has been placed on the market recently by the General Pneumatic Tool



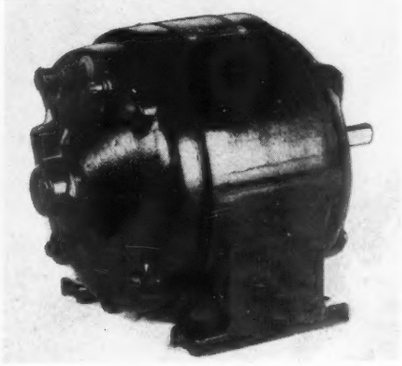
Corporation, 4820-24 West Lake St., Chicago, Ill. This outfit, recommended for all interior and exterior maintenance work, consists of the following equipment: One 3x3½-in. air-cooled air compressor with a capacity of 7.5 c.f.m. and equipped with an automatic unloader; 1½-hp. motor; an underslung air receiver with safety pop valve, drain cock, and gage; model "V" spray gun; No. 202 4-gal. pressure container; two 25-ft. lengths of ¼-in. rubber hose with connections and one 25-ft. section of ⅜-in. hose with connections.

The air compressor, electric motor, and air receiver are mounted on a steel platform truck with three steel wheels.

Westinghouse Clutch-Type Motor

A HIGH starting torque, ¼-hp., 1,725-r.p.m., split-phase motor, identified as Type CAH clutch motor, has been announced by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. Starting current is constant, regardless of the load, making it especially suitable for driving small machines on 110-volt lighting circuits, and which must, therefore, meet the current requirements established by certain utility companies.

The design of the clutch mechanism, which gives the motor the very high starting torque, makes it possible for it to start heavy loads. Under normal conditions, the motor carries the load up to speed in the same manner as an ordinary split-phase motor. However, in cases where the load is stiff, or is difficult to start because of thick oil or

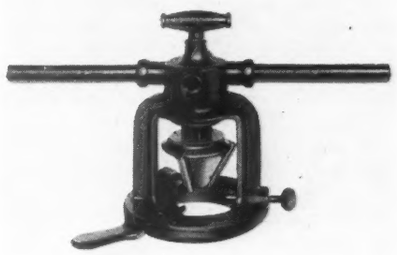


compression, as in the case of pumps or compressors, the motor delivers a series of power impulses that tend to overcome the static friction and inertia of the load, and bring it up to speed. These power impulses increase until the load is started, or until approximately 680 per cent full load torque is developed.

Oster-Williams Four-Inch Reamer

FOUR-INCH pipe is the capacity of the No. 414 reamer placed on the market by The Oster Manufacturing Company, Cleveland, Ohio. This unit was designed primarily to be used with the Oster No. 414 Power Boy, but provision has been made so that two additional handles may be used for hand operation.

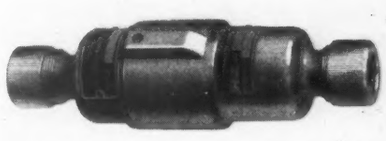
There are three reaming blades, so designed that they can be replaced if



necessary. The body of the tool is made of certified malleable iron and is fully guaranteed against breakage.

Ralco Cord Connector

THE Ralco Manufacturing Company, 123 N. Albany Ave., Chicago, Ill., has brought out a device for connecting two cords together. It consists of the HF type receptacle and a standard PRG plug. They are made in two-, three-,



and four-pole units for use on 30 and 60 amp. and have been approved as circuit-breaking devices on 250-volt d.c. or 600-volt a.c. circuits.

Lenk Alcohol Blow Torch

THE Lenk Manufacturing Company, Newton Lower Falls, Mass., is marketing an alcohol blow torch made of polished nickel-plated brass. This blow torch is of double burner construction.

With one turn of a thumb-screw the burner, which produces a 2,200-deg. F. blast, is released and a 1,700-deg. F. needle point flame is generated. A cleaning pin is kept securely in the handle.

Westinghouse Welding Electrodes

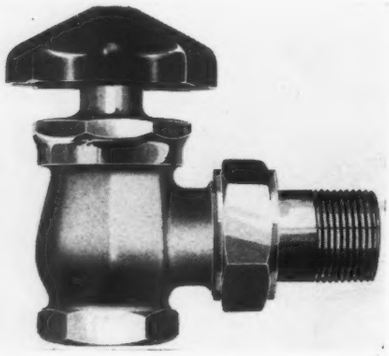
"FLEX-ARC Welding Electrode" is the name of the general-purpose steel-welding electrode announced by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. Welds made by these electrodes are said to be machined easily, free from slag, oxidation, and gas inclusions. Tensile strengths ranging from 55,000 to 60,000 lb. per sq. in. are claimed without any special skill on the part of the operator.

Sulcoat and bright-finish electrodes are manufactured from steel made by the basic open-hearth process. They meet the American Welding Society Specifications E-No. 1-B.

Flex-Arc electrodes are packed into standard 50-lb. bundles, securely wired, wrapped in burlap, and tagged to show size, grade, heat, and number. They are carried in the following sizes: 1/16 in., 3/32 in., 1/8 in., 5/32 in., 3/16 in., and 1/4 inch.

Marsh Radiator Valve

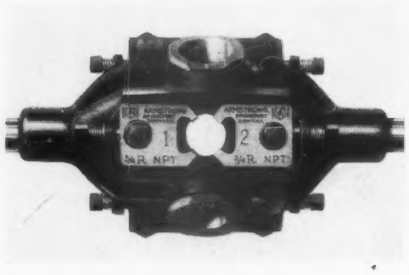
RADIATOR valves of improved design have been introduced by Jas. P. Marsh & Company, 2073 Southport Ave., Chicago, Ill. The valve body is made of high-grade cast steam brass. Proportions of the body permit a full flow of steam through the valve when wide open. There is no raised edge at the valve seat, which makes it rapid draining and dirt free. Bodies are regularly furnished in angle, straightway, offset and right and left hand corner types in all sizes from 1/2 to 2 in. inclusive.



Valves are regularly furnished with oval or lever-type handles of Bakelite, with plain or graduated disk and index pointers. They are also furnished with extension stems or lock shield attachments.

Armstrong Three-Way Diestock

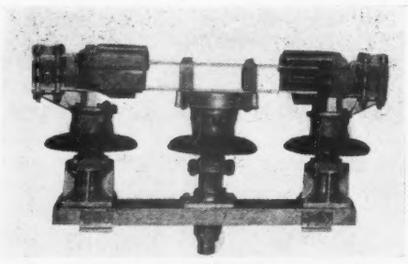
THE Armstrong Manufacturing Company, Bridgeport, Conn., announces a three-way diestock so constructed as to contain three sets of dies and adjustable for threading oversized and under-



sized threads. Bushings are removable so that close nipples can be made. The "Kalorizing" treatment given the dies is claimed to make them stronger.

Delta-Star Disconnecting Switches

AN improved line of heavy-capacity gang-operated disconnecting switches has been developed by the Delta-Star Electric Company, Chicago, Ill. They are of the horizontal-break double-blade type with double, self-aligning full-floating contacts, sleet shields,



ice- and corrosion-breaking blade movement and ball bearings on rotating insulator stack. Clamp-type terminal lugs for any size of copper tubing can be furnished.

The switch illustrated is rated 7,500 volts, 2,000 amp. and provided with insulators of high torsional and cantilever strength, with flashover values in excess of the usual rating.

Trumbull Switch Pedestal

CAST-IRON pedestals for M7½, TM, and RM type switches are now being offered by the Trumbull Electric Manufacturing Company, Plainville, Conn. The pedestals may be used to

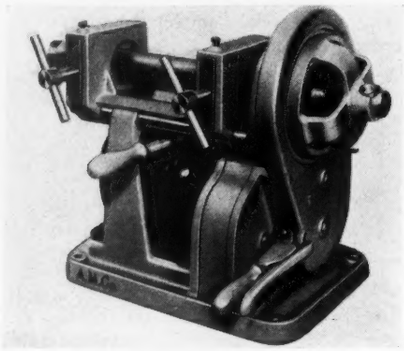
mount switches in the base of machines or for floor mounts.

When used with M7½ switches, the pedestals will be supplied painted gray. They are painted black for RM and TM units.

Axelson Threading Machine

A PIPE threading machine, designed for a wide range of uses, has been developed by the Axelson Manufacturing Company, Ltd., Los Angeles, Calif. The pipe that is to be threaded remains stationary while the standard square die is revolved, cutting the thread. Long stands of assembled or bent pipe may be threaded conveniently as it is unnecessary to rotate the units.

The work is gripped by two jaw chucks which are practically automatic and instantaneous in action. Threads can be cut on material from 1/2 to 2 in. in diameter. Power is supplied by a 1/2-hp. compound-wound motor, installed directly beneath the pipe holder brackets. The motor may be used on 110 or 120 volts, either 50 or 60 cycle.



Barrett-Cravens Multiple Lift Trucks

MULTIPLE lift trucks in two sizes, model T with a carrying platform 18 in. wide, and model TK with a carrying platform 24 in. wide, have been announced by the Barrett-Cravens Company, State and 87 Sts., Chicago, Ill. The trucks have a capacity of 6,000 lb. and are capable of lifting the load with the handle located anywhere in an arc of 200 deg. Another feature is that the load may be lifted with a minimum of two and a maximum of eight strokes, depending upon the weight of the load and the strength of the trucker.

Timken roller bearings are used in the wheels and in the kingbolt. The lifting mechanism is provided with ball bearing equipment. Hinged covers protect the mechanism from dust and dirt. The hydraulic check is equipped with a stuffing box to eliminate oil leakage

and the consequent rapid dropping of the load. Another safety feature is the double-action pawl which prevents the handle from fouling or flying up when the load is being tripped. When idle, the handle is held off the floor by a spring holdup. An Alemite lubricating system is used throughout.

United States Flexible Shaft

ONE of the features of the flexible shaft introduced by the U. S. Electrical Tool Company, Cincinnati, Ohio, is the patented "V-disk" speed changer illustrated. Attached to any standard U. S. flexible shaft machine, it provides eight different speeds from 1,000 to 11,000 r.p.m. Another feature is a copyrighted speed chart furnished with each machine. A glance at this chart by the mechanic tells him which tool and which speed are proper for every job on any kind of metal.

The casing expands and contracts, allowing for stress and absorbing the give-and-take heretofore thrown onto the shaft. This is claimed to be an important advantage because it does away completely with the necessity of the shaft's slipping to and from the

motor while under power. Stress is further relieved by a slide coupling at the motor end of the casing.

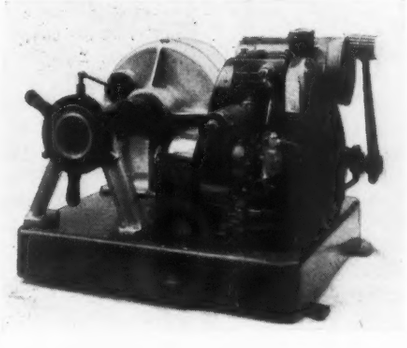
The shaft itself is made of piano wire, wound cold under uniform tension, each layer wound in the opposite direction from the layer next to it, and progressing in size from the center to the outside. It is fastened rigidly to the motor and has a coil bearing inserted between itself and the casing. The hand piece turns on ball bearings in a grease-tight compartment.

Oster-Williams "No. 412 Power Boy" Pipe Threading Machine

THE "No. 412 Power Boy," made by the Oster Manufacturing Company, Cleveland, Ohio, is now available with a gasoline engine drive that will operate for ten hours on a single gallon of gasoline, it is claimed.

The gasoline motor is a 1-hp., single-cylinder, air-cooled Briggs & Stratton motor. It is the regular 4-cycle type and has a 2½-in. bore and 2¼-in. stroke. It is equipped with a high-tension magneto and uses standard motor cycle spark plugs that can be obtained at practically any garage or service station. A hand starter and an Eclipse motor cycle clutch are standard equipment. The motor is connected to the Power Boy with a roller chain.

The Power Boy will thread and cut pipe up to 2 in. without the auxiliary drive. With the auxiliary drive it can be used for pipe up to 4 inches.



Arrow Electric Locking Ring and Cap

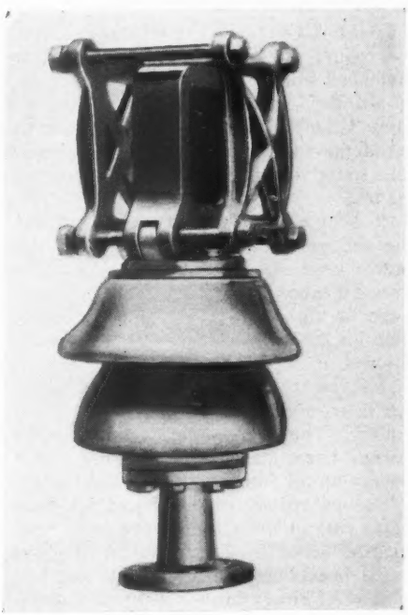
A LOCKING ring and cap assembly, to prevent attachment plugs from pulling out, has been developed by the Arrow Electric Division of the Arrow-Hart & Hegeman Electric Company, Hartford, Conn. With it, it is possible to convert any single convenience outlet into a locking receptacle.

Screws in the flush plates of existing installations secure the assembly.

Champion Busbar Support

THE Champion Switch Company, Kenova, W. Va., announces the 25-kv., outdoor, high-strength bus support illustrated.

This support is designed for use with

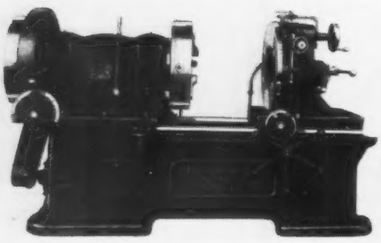


high current buses—both the clamp and center spacer being made of non-magnetic metal. The spacers have large clamping surfaces preventing cutting into the bus as the holding bolts draw down.

Jarecki High-Speed Pipe Threader

INCREASED production and lower operating costs are two of the claims made for the high-speed, heavy-duty threader introduced by the Jarecki Manufacturing Company, Erie, Pa. The automatic, self-opening die head covers the entire range—the standard range of 2½ to 8 in. as well as the extra range of 1½ to 2 in. Two sets of chasers, 6 to the set, are regularly furnished, both sets threading the entire standard range, 2½ to 8 in., 8 thread. It is only necessary to change chasers to change thread pitch.

When it is desired to thread 1½- to



2-in. pipe which requires 11½ thread, chasers can be furnished at an extra charge.

Timken bearings are used throughout. A range of 6 spindle speeds gives an average threading speed of 29 f.p.m. The machine is said to cut off 8-in. pipe at over 100 feet per minute.

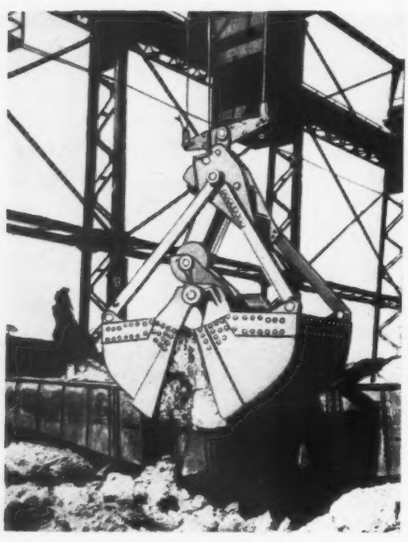
Erie Heavy-Duty Bucket

THE Erie Steel Construction Company, Erie, Pa., has developed a clamshell bucket for heavy-duty service. It will be known as the "Erie Heavy-Duty Clamshell Bucket" and is built to stand up under the severe service usually found in steel mills and industrial plants.

It is of all steel construction and has the sheaves at the extreme end of the power arm where they will exert the greatest amount of leverage. The ropes have straight leads without S bends. The bucket can be reeved with 3, 4, or 5 parts of closing line.

The head of the bucket is provided with large bearings and built-in guide rollers. The head plate strengthens the corner bars, placing the digging strain evenly on all four corners of the bucket.

Scoops are well banded and the back band ties in with the power arm, thus making three thicknesses of metal at the usual breaking point. The lips are furnished of either high-carbon or manganese steel as desired. Buckets are now available in capacities from 2 to 6 cu. yards.



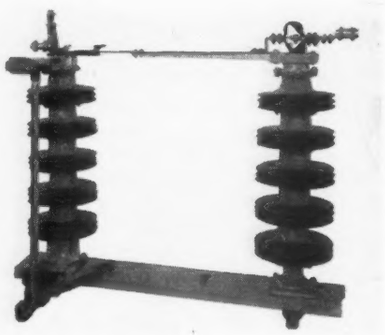
McGill Portable Lamp Guard

McGILL MANUFACTURING COMPANY, Valparaiso, Ind., is now marketing a portable lamp guard in four types, known as the 7000 series. The handle of the guard is made of rubber compound, making it flexible and unbreakable. Type 7000-SR has a 660-

watt Levolier socket with insulated fiber lever which can be turned off with either thumb or finger. This guard will withstand a pressure of approximately 800 lb. without breaking the bulb.

Delta-Star Disconnecting Switch

DELTA-STAR ELECTRIC COMPANY, 2400 Block, Fulton St., Chicago, Ill., has developed a gang-operated, three-pole, 66-kv., 600-amp.

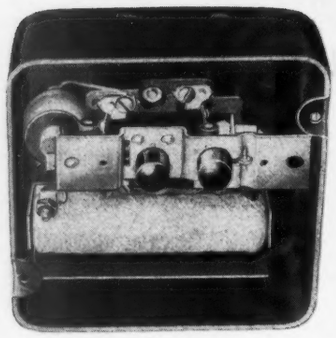


disconnecting switch with gang-operated ground blades.

The horizontal operating blade is equipped with ice-breaking mechanism. Terminal lugs are of the solderless type, the contacts of the full-floating form and the insulators are of the fog-type design.

Cutler-Hammer Resistor Starter

CUTLER-HAMMER, Inc., 150 12th St., Milwaukee, Wis., announces a resistor-type starter for fractional hp., d.c. and single-phase a.c. motors. This starter is designed for those applications where power company rulings require that the inrush current of small motors connected to lighting circuits be held within definite limits, and where the high inrush current incident to starting across-the-line is otherwise objectionable. On starting, a resistance is inserted in series with the motor. As the motor accelerates and the inrush current decreases, the starter automatically short-circuits the resistor, connecting the motor across-the-line. The starter is pushbutton operated and provides thermal overload protection to the motor.



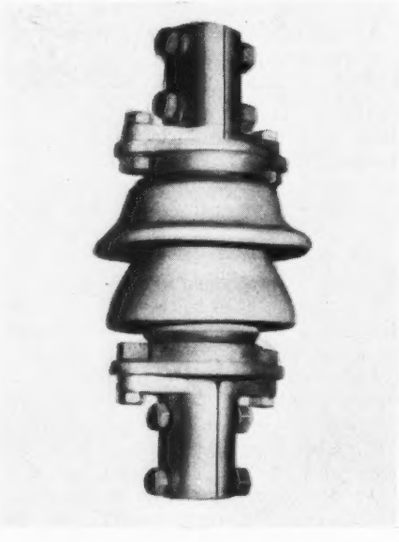
The overload relay acts directly on the contact mechanism. Small overloads, and overloads of short duration, do not trip the mechanism—the motor is disconnected only when it is in danger of being burned out.

The inclosing case is a standard, double wiring box which can be mounted easily on the machine, on the wall, or at any other point convenient to the operator. Starters can also be obtained without the inclosing case for building into the pedestal or other part of a machine.

Champion Switch Shaft Insulators

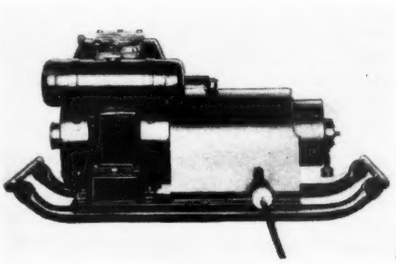
FOR use in insulating the shafts of gang-operated switches, the Champion Switch Company, Kenova, West Va., has developed the double-petticoat, high-strength insulator section illustrated.

It is equipped with fittings permitting quick and easy attachment to the switch shaft. Its use provides additional safety in case of faulty grounds or poor ground connections to switch bases.



Westinghouse Portable Power Unit

A PORTABLE power plant weighing 120 lb., and capable of delivering 1,000 watts, has been developed by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa. This plant is provided with duraluminum skids which make it easy to transport. It is powered by a gasoline engine developing 2 hp. at 4,000 r.p.m. There is only one exposed moving part. All other parts are inclosed in a sealed bath of oil, protected from dust and dirt. The gasoline tank has a capacity of 2½ quarts which is claimed to be sufficient to operate the engine for three hours under full load conditions. The engine speed is controlled by an automatic mechanical governor. Accurate speed adjustment is provided between 1,800 and 4,000 r.p.m.



This unit has been designed to meet the needs of construction and repair crews for a convenient and portable source of power.

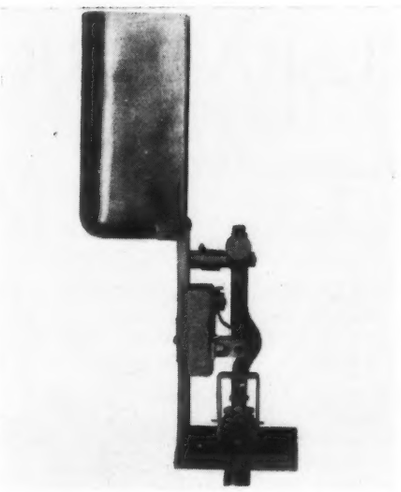
Cincinnati Cincinnatus Duoflex Belt

A DEPARTURE from the usual construction in transmission belting is announced by the Cincinnati Rubber Manufacturing Company, Cincinnati, Ohio. This belt, called "Cincinnatus Duoflex" because of its duo-flexibility both crosswise and lengthwise, is designed to give greater pulley contact, thus delivering more horsepower. It is built to fit all kinds of pulleys. The reason for the close pulley hug is the automobile tire cord insert giving crosswise flexibility and exceptional adhesion under the seam.

General Electric Thermostat for Melting Pots

A QUARTZ-rod thermostat for controlling the temperature of melting pots for use with lead, tin, babbitt, solder, and so on, has been announced by the General Electric Company, Schenectady, New York.

The thermostat consists of an inclosed switch and a nickel-chrome iron tube extending from its base and surrounding a steel piston and quartz rod. The thermostat has a temperature range of from 450 to 950 deg. F. and will control temperatures to within plus or minus 14 deg. F. of its setting. The contacts are designed to carry any current necessary to operate any standard automatic control panel.

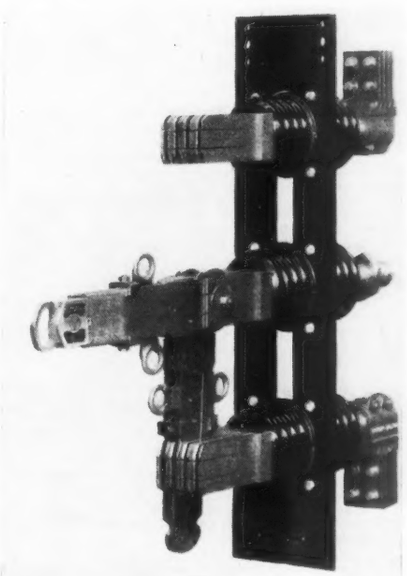


Delta-Star Transfer Switches

TRANSFER or selector switches made by the Delta-Star Electric Company, 2400 Block, Fulton St., Chicago, Ill., are now equipped with an additional safety lock at the center in addition to the usual lock at the blade end.

These safety locks can be set to stop the blade at any angle of open position. The switch shown has the lock adjusted to stop the blade just as it reaches the contact clips — this position preventing opening of the circuit under load.

If, through error, operation under load is started, the switch may be closed immediately in the locked position—just free of the contact clips and before a long arc is started.



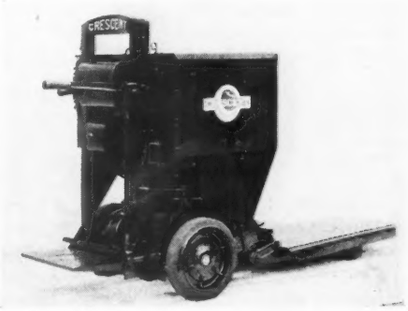
Crescent Power Lift Truck

AN electric industrial power lift truck for use with hand-truck platform skids 7 in. high or over has been developed by the Crescent Truck Company, Lebanon, Pa. The general specifications of this truck are as follows:

Capacity, 3,500 lb.; overall length, 88 in.; overall width, 33 in.; turning radius, 7 ft.; drive, spur gear with a reduction of 19 to 1.

The lifting platform is 20-in. wide and 40-in. long. Both the driving motor and the elevating motor are of General Electric design. There are two speeds forward and two speeds reverse. The brake foot pedal interlocks with control mechanism. All moving parts are bronze bushed and are provided with Alemite fittings. Fafnir ball bearings and Timken roller bearings are used throughout. Batteries are of standard Exide or Edison assembly.

Cantilever spring suspension is used on the driving unit. Rubber tires are used on all four wheels.



Cutler-Hammer Three-Position Pilot Switch

FOR motor-driven pumps, compressors, and similar machines which are controlled by an automatic pilot device such as a float switch, pressure switch, time clock, and so forth, Cutler-Hammer, Inc., 150 12th St., Milwaukee, Wis., has developed a three-position pilot switch.

The operating lever can be placed in either the "automatic," "off" or "manual" position. When turned to "automatic," the automatic pilot device is in circuit and normal, automatic operation is obtained. With the lever in the "off" position, the pilot circuit is opened and the motor cannot be started from any other control point. Turning the lever to the "manual" position closes the control circuit direct and the motor will run continuously regardless of any other control devices as long as there is operating voltage on the line.

The switch consists of a two-button pushbutton switch inside the case, the buttons of which are operated by a cam attached to the operating lever. The lever will remain in any one of the three positions.

TRADE LITERATURE

You Should Know About

Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of bulletin or catalog described, as given in these columns.

* * *

(233) POWER DRIVES—Bulletin L400, Worthington "Multi-V-Drive for Power Transmission."—Worthington Pump & Machinery Corporation, 2 Park Ave., New York, N. Y.

(234) LUBRICATION—Folder, 12 pages "Farval" dualine heavy-duty centralized system of lubrication.—Lubrication Devices, Inc., Battle Creek, Mich.

(235) AIR COMPRESSORS — Catalog 372 "Lindsay Portable" direct drive compressors.—P. K. Lindsay & Company, Inc., 370-384 Atlantic Ave., Boston, Mass.

(236) M. G. SETS—Bulletin 401, 8 pages high-cycle m.g. sets for use with high-cycle tools.—Burke Electric Company, Erie, Pa.

(237) PRESSED STEEL PRODUCTS—General catalog, 128 pages, pulleys, shaft hangers, hand trucks, reels, spools and beams, miscellaneous stampings and Sprucolite motor pulleys.—The American Pulley Company, 4200 Wissahickon Ave., Philadelphia, Pa.

(238) MOTOR BRUSHES—Catalog 24, 56 pages, Speer motor and generator brushes and carbon products.—Speer Carbon Company, St. Marys, Pa.

(239) WASHFOUNTAINS—Folder, 4 pages "Let's Look Into Your Washroom Costs," complete descriptions of this equipment for group washing.—Bradley Washfountain Company, 2203 Michigan St., Milwaukee, Wis.

(240) TRAMRAIL SYSTEMS—Form TR, photographs and descriptions of Cleveland tramrail systems in the rubber industry.—Cleveland Electric Tramrail, Division of the Cleveland Crane & Engineering Company, Wickcliffe, Ohio.

(241) CONTROL—Industrial control catalog GEA-606B.—General Electric Company, Schenectady, N. Y.

(242) CONVEYOR DRIVES—Book 1191 illustrates and describes the complete line of Caldwell screw conveyor drives.—H. W. Caldwell & Son Company, 2410 W. 18th St., Chicago, Ill.

(243) SWITCHGEAR — Circular 1892, 8 pages, metal-inclosed, truck-type switchgear.—Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

(244) SPEED REDUCERS—Catalog 25, the complete line of speed reducers of small and fractional-horsepower capacities.—Winfield H. Smith, Inc., Springville, N. Y.

(245) DISCONNECTING SWITCHES — Folder GEA-1096A, Type LG-118B indoor disconnecting switches.—General Electric Company, Schenectady, N. Y.

(246) MOTORS—Bulletin 171, 16 pages, a discussion, complete with curves and illustrations, of the problem of poor power factor and the application of the Fynn-Weichsel motor to its solution.—Wagner Electric Corporation, 6400 Plymouth Ave., St. Louis, Mo.

(247) CONVEYORS—Catalog, "Economical Material Handling," 48 pages of pictures and descriptions of the conveyors manufactured and installed by this company.—Kurth and Knapp Manufacturing Company, Detroit, Mich.

(248) CENTRIFUGAL COMPRESSORS—Bulletin GEA-1280, 12 pages, centrifugal compressors and blowers.—General Electric Company, Schenectady, N. Y.

(249) WELDING—"Better Welds with Armco Ingot Iron," 40 pages of illustrations and descriptions of typical installations of welded ingot iron.—The American Rolling Mill Company, Middletown, Ohio.

(250) HYDRAULIC POWER UNITS—Form No. IJ430, 20 pages of pictures illustrating many of the uses of Blackhawk hydraulic power units.—Blackhawk Manufacturing Company, 148 Broadway, Milwaukee, Wis.

(251) AFTERCOOLERS — Bulletin 150, 8 pages, design and construction details of Pennsylvania aftercoolers.—Pennsylvania Pump and Compressor Company, Easton, Pa.

(252) STARTERS — Folder GEA754A, semi-automatic reduced-voltage starters for synchronous motors.—General Electric Company, Schenectady, N. Y.

(253) MAGNETIC BRAKES—Bulletin 104-AF, Type WB magnetic brakes for both mechanical and electrical operation. A copy will be furnished upon request.—The Electric Controller and Manufacturing Company, Cleveland, Ohio.

(254) POWER TRANSMISSION—Folder, 12 pages, Medart V-Belt drives, price list and data for designing a typical installation.—The Medart Company, Potomac and De Kalb Sts., St. Louis, Mo.

(255) LIGHTING — Bulletin GEA-161E, superseding GEA-161D, 28 pages of construction, installation and application data on Novalux floodlighting projectors.—General Electric Company, Schenectady, N. Y.

(256) VACUUM PUMPS—Several salient features of the "Condo-Vac," and return line vacuum pump.—Chicago Pump Company, 2326 Wolfram St., Chicago, Ill.

(257) WELDING—"Automatic Arc-Welding Data" Bulletin 14, a number of automatic arc-welding applications, as well as actual cost comparison of hand and automatic welding. A copy will be sent upon request.—Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

(258) MOTORS—Bulletin 101, Type S and SV induction motors.—Burke Electric Company, Erie, Pa.

(259) MATERIALS HANDLING — Folder, photographs and descriptions of Cleveland tramrail systems in foundries.—Cleveland Electric Tramrail, Division of the Cleveland Crane & Engineering Company, Wickliffe, Ohio.

(260) PHOTO-ELECTRIC CELLS—Booklet, "The Photolytic Cell," 34 pages, interesting information on photo-electric phenomena, a general discussion of present photo-electric cells, and a detailed description of the Arcturus Photolytic cell.—Arcturus Radio Tube Company, 260 Sherman Ave., Newark, N. J.

Coming Events

The Electric Hoist Manufacturers Association—Next meeting, September, 1930, Montour Falls, N. Y. Secretary, E. Donald Tolles, 165 Broadway, New York, N. Y.

National Metal Congress—Twelfth Annual Congress and Exposition, Stevens Hotel, Chicago, Sept. 22 to 26. W. H. Eisenman, secretary of the A. S. S. T., 7016 Euclid Ave., Cleveland, Ohio, director. In conjunction—meetings of the A.S.M.E., A.I.M.M.E., and A.W.S.

American Welding Society — Annual fall meeting, Congress Hotel, Chicago, Ill., September 22 to 26. W. M. Spraragen, 29 West 39th St., New York, N. Y.

American Gear Manufacturers Association — Fall meeting, Hotel Clifton, Niagara Falls, Sept. 29, 30, and Oct. 1. T. W. Owens, Secretary, 3608 Euclid Ave., Cleveland, Ohio.

National Safety Council — 19th Annual Safety Congress, Sept. 29 to Oct. 4. Hotels William Penn, and Fort Pitt, Pittsburgh, Pa.

Illuminating Engineering Society — Twenty-fourth annual convention, Hotel John Marshall, Richmond, Va., Oct. 7 to 10, 1930. Society headquarters, 29 West 39th St., New York, N. Y.

Society of Industrial Engineers—17th National Convention, Mayflower Hotel, Washington, D. C., Oct. 15 to 17. George C. Dent, 1815 Engineering Bldg., 205 W. Wacker Drive, Chicago, executive secretary.

Ninth National Exposition of Power and Mechanical Engineering—Grand Central Palace, N. Y., Dec. 1 to 6, 1930. Managers, International Exposition Company.

Fifth Midwest Engineering and Power Exposition — Coliseum, Chicago, Feb. 10 to 13, 1931. Managers, Midwest Engineering Exposition, Inc., 308 West Washington St., Chicago, Ill.

National Fire Protection Association —35th annual meeting, Toronto, Can., May 11 to 17, 1931. Association headquarters, 60 Batterymarch St., Boston, Mass.

INDUSTRIAL ENGINEERING'S DATA SHEETS

Motor Wiring Tables

(Continued from the August issue)

TWO-PHASE, SQUIRREL-CAGE INDUCTION MOTORS—*Continued*

Voltage	Hp.	Full load Amperes	Wire size Gage No. or circular mils			Conduit size	Running protection		Max. rating branch circuit fuses		Voltage drop per 100 ft. (single distance) r. c. wire
			Rubber covered	Varnished cambric	Slow-burning	Inches	Max. fuse rating Amperes	Max. setting time limit protective device Amperes	Full voltage starting Amperes	Reduced voltage starting Amperes	Percent
	½	0.9	14	14	14	¾*	2**	1.25	15	.....	0.09
	¾	1.0	14	14	14	¾*	2**	1.25	15	.....	0.10
	1	1.2	14	14	14	¾*	2**	1.50	15	.....	0.12
	1½	1.6	14	14	14	¾*	2	2.00	15	15	0.15
	2	2.0	14	14	14	¾*	3**	2.50	15	15	0.19
	3	3.0	14	14	14	¾*	4	3.75	15	15	0.29
	5	6	14	14	14	¾*	8	7.50	20	15	0.57
	7½	7	14	14	14	¾*	10	8.75	25	20	0.67
	10	10	14	14	14	¾*	15	12.50	30	25	0.96
	15	13	12	14	14	¾	20	16.25	40	35	0.78
	20	19	10	12	12	1*	25	23.75	60	50	0.72
550	25	22	8	10	10	1	30	27.50	70	60	0.52
	30	27	8	8	8	1	35	34.0	.....	70	0.64
	40	35	6	6	8	1¼	45	44.0	.....	80	0.52
	50	43	4	6	6	1½	60	54.0	.....	90	0.40
	60	52	4	4	6	1½	70	65.0	.....	110	0.49
	75	62	3	4	4	1½	80	77.5	.....	125	0.46
	100	85	0	2	2	2	110	106.5	.....	175	0.32
	125	108	00	0	1	2½	150	135.0	.....	225	0.32
	150	124	000	00	0	2½	175	155.0	.....	250	0.29
	200	166	0000	000	00	2½	225	208.0	.....	350	0.31

TWO-PHASE, WOUND-ROTOR INDUCTION AND HIGH-REACTANCE TYPE SQUIRREL-CAGE INDUCTION MOTORS

Voltage	Hp.	Full load Amperes	Wire size Gage No. or circular mils			Conduit size for r. c. wire Inches	Running protection		Max. rating branch circuit fuses		Voltage drop per 100 ft. (single distance) r. c. wire Percent
			Rubber covered	Varnished cambric	Slow-burning		Max. fuse rating Amperes	Max. setting time limit protective device Amperes	Wound-rotor Amperes	High-reactance type Amperes	
110	1	6.8	14	14	14	¾*	10*	8.50	15	20	3.2
	2	12.5	12	14	14	¾	20*	15.75	20	35	3.8
	3	17.3	10	12	12	1*	25	21.75	30	45	3.3
220	1	3.4	14	14	14	¾*	6**	4.25	15	15	0.81
	2	6.2	14	14	14	¾*	8**	7.75	15	20	1.5
	3	8.7	14	14	14	¾*	12	11.00	15	25	2.1
	5	13	12	14	14	¾	20	16.25	20	35	2.0
	7½	22	8	10	10	1	30	27.50	35	60	1.3
	10	24	8	10	10	1	30	30.00	40	60	1.4
	15	39	6	6	8	1¼	50	49.0	60	80	1.5
	20	49	4	6	6	1½	60	61.5	80	100	1.2
	25	58	3	4	4	1½	70	72.50	90	120	1.1

INDUSTRIAL ENGINEERING'S DATA SHEETS

Motor Wiring Tables

(*Continued from the preceding page*)

THREE PHASE WOUND-ROTOR AND HIGH-REACTANCE TYPE SQUIRREL-CAGE INDUCTION MOTORS—*Continued*

Voltage	Hp.	Full load Amperes	Wire Size Gage No. or circular mils			Conduit size for r. c. wire Inches	Running protection		Max. rating branch circuit fuses		Voltage drop per 100 ft. (single distance) r. c. wire Percent
			Rubber covered	Varnished cambric	Slow-burning		Max. fuse rating** Amperes	Max. setting time limit protective device Amperes	Wound rotor Amperes	High reactance type Amperes	
220	30	71	2	3	4	1½	90	89.0	110	150	1.05
	40	92	0	1	2	2	125	115.0	150	200	0.86
	50	110	00	0	1	2½	150	137.5	175	225	0.81
	60	130	000	00	0	2½	175	162.5	200	300	0.76
	75	163	0000	000	0	2½	225	204.0	250	350	0.76
	100	213	300,000	0000	000	3	300	266.0	350	450	0.70
	125	269	500,000	350,000	250,000	3½	350	336	450	600	0.53
	150	315	500,000	400,000	300,000	3½	400	394	500	630***	0.62
	200	430	800,000	600,000	500,000	4½	600	538	645***	860***	0.53
440	1	1.7	14	14	14	¾*	3**	2.25	15	15	0.20
	2	3.1	14	14	14	¾*	4**	4.00	15	15	0.37
	3	4.3	14	14	14	¾*	6	5.50	15	15	0.51
	5	6.5	14	14	14	¾*	10	8.25	15	20	0.78
	7½	11	14	14	14	¾*	15	13.75	20	30	1.3
	10	12	14	14	14	¾*	15	15.00	20	30	1.4
	15	20	10	12	12	1*	25	25.0	30	50	0.95
	20	25	8	8	8	1	35	31.5	40	70	0.74
	25	29	6	8	8	1¼	40	36.5	45	80	0.54
	30	36	6	6	8	1¼	45	45.0	60	80	0.67
	40	46	4	6	6	1½	60	57.5	70	100	0.54
	50	55	4	4	6	1½	70	69.0	90	125	0.65
	60	65	2	4	4	1½	80	81.5	100	150	0.48
	75	82	0	2	2	2	110	102.5	125	175	0.38
	100	106	00	0	1	2½	150	132.5	175	225	0.39
	125	135	000	00	0	2½	175	169	225	300	0.40
	150	157	0000	000	00	2½	200	196	250	350	0.32
	200	215	300,000	250,000	000	3	300	269	350	450	0.35
550	1	1.3	14	14	14	¾*	2**	1.75	15	15	0.12
	2	2.5	14	14	14	¾*	4**	3.25	15	15	0.24
	3	3.4	14	14	14	¾*	6	4.25	15	15	0.33
	5	5.2	14	14	14	¾*	8	6.50	15	15	0.50
	7½	9	14	14	14	¾*	12	11.25	15	25	0.86
	10	10	14	14	14	¾*	15	12.50	15	25	0.96
	15	16	12	12	14	¾	20	20.0	25	40	0.96
	20	20	10	12	12	1*	25	25.0	30	50	0.76
	25	23	8	10	10	1	30	29.0	35	60	0.55
	30	28	8	8	8	1	35	35.0	45	70	0.67
	40	37	6	6	8	1¼	50	46.5	60	80	0.55
	50	44	4	6	6	1½	60	55.0	70	90	0.41
	60	52	4	4	6	1½	70	65.0	80	110	0.49
	75	66	2	4	4	1½	80	82.5	100	150	0.39
	100	85	0	2	2	2	110	106.5	150	175	0.32
	125	108	00	0	1	2½	150	135.0	175	225	0.32
	150	125	000	00	0	2½	175	156.5	200	250	0.29
	200	173	0000	0000	00	2½	225	216.0	300	350	0.32

*Conduit one size smaller may be used under certain conditions. N.E.C. 503-q.
**Motors of 2 hp. or less may be protected by the branch circuit fuses only. N.E.C. 808-a, exception (1).
***Circuit-breaker settings. Fuses not permitted. N.E.C. 805-l.